BOTHALIA

Vol. 10, Part 1

Edited

by

L. E. Codd, D.Sc.

Botanical Research Institute
Navorsingsinstituut vir Plantkunde

Department of Agricultural Technical Services
Departement van Landbou-Tegniese Dienste

South Africa/Suid-Afrika

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Vol. 10, Part 4

PLATE 1.—Edwin Percy Phillips

Bothalia 10, 1: 1–3

Edwin Percy Phillips, M.A., D.Sc. (1884-1967)

by

M. D. Gunn

Edwin Percy Phillips, who was Chief of the Division of Botany and Plant Pathology, Pretoria (the present Botanical Research Institute), from 1939 to 1944, died in Cape Town on 12th April, 1967. The son of Ralph Edward Phillips, a Cape Town businessman, and Edith Minnie Phillips, née Crowder, he was born on 18th February, 1884, at York House, Hall Street, Sea Point. There were nine children in the family, five sons and four daughters. His grandfather, Samuel Phillips, was a well-known merchant and owned the fine property " Bellwood House ", with its adjoining estate, below Lions Head, Sea Point, in the early 1870's.

After attending the South African College School he entered the South African College (later to become the University of Cape Town), where he came under the stimulating influence of the inspired teacher and botanist, Prof. H. H. W. Pearson. In 1905 he obtained the B.A. degree with first class honours in botany and, in 1908, his M.A.

In 1907 he was appointed as assistant in the herbarium of the South African Museum, of which Prof. Pearson was then Honorary Curator, and applied himself with vigour to studying and collecting the local flora. The result was that, in 1910, he was granted ten months leave of absence by the Trustees of the Museum, to proceed to the Herbarium of the Royal Botanic Gardens, Kew. Here he dealt with the family Proteaceae, a group of which he had first hand field knowledge, in collaboration with the Kew botanists Otto Stapf and John Hutchinson for the " Flora Capensis ".

When Prof. Pearson resigned as honorary curator of the S.A. Museum herbarium in 1911 to become custodian of the Bolus Herbarium at the South African College, E. P. Phillips was appointed as assistant in charge of the Museum herbarium.

In 1912 he married Edith Isabel Dawson of Sea Point. The union was to prove a happy one. Two daughters were born of the marriage and he was always a devoted husband and father.

On his return to South Africa he worked for some years on collections sent in by Mme. A. Dieterlen, wife of a French missionary stationed at Leribe in northern Lesotho. In order to gain a better knowledge of the flora *in situ* he visited the territory in 1913. His field studies, together with the taxonomic work entailed, resulted in a paper entitled "A contribution to the flora of the Leribe Plateau and environs: with a discussion on the relationships of the flora of Basutoland, the Kalahari, and the south-eastern regions ", for which he was awarded the degree of D.Sc. by the University of the Cape of Good Hope in 1915.

His collecting localities were mainly in the western Cape where, as a keen mountaineer and member of the Cape Mountain Club (of which he was for some time Secretary), he actively explored and collected in the rich flora of the Cape mountains. Dr. Phillips was a member of the Percy Staden Memorial Expedition, which explored the Kamiesburg, Gifberg and Olifants River mountains during September 1911.

In May, 1918, Dr. Phillips joined the Government Service as Curator of the National Herbarium of the Division of Botany, a section of the Department of Agriculture, Pretoria. At that time the herbarium was a relatively small one, started in 1903 by Joseph Burtt Davy and, on his retirement in 1913, incorporated with the Plant Pathology Section into the Division of Botany under Dr. I. B. Pole Evans.

When Dr. Phillips took charge of the National Herbarium, a Botanical Survey of the Union of South Africa was being conducted and this led to the rapid growth of the Herbarium which was also supplemented by donations of important private collections. Shortly after his appointment, three scientific publications were started by the Division. The first of these was the series of Botanical Survey Memoirs, which appeared initially in 1919 and of which he was author of Memoirs 9, 10 and 25. He was responsible for the major part of the text in the first 20 volumes of the illustrated serial, The Flowering Plants of South Africa, issued in 1920. Bothalia, a record of the contributions from the National Herbarium, Pretoria, appeared in 1921, and was the venue for many of his botanical papers.

During twenty-one years as botanist, and Chief from 1939–1944 of the Division of Botany and Plant Pathology, he published some 200 scientific papers and several major works, including " The Genera of South African Flowering Plants ", " South African Grasses ", " The Weeds of South Africa " and after his retirement he was re-employed to complete a second edition of the " Genera ". His last contribution to South African botany was spontaneously and gratuitously given as a tribute to a former friend and colleague, C. A. Smith, when he undertook the gigantic task of editing " Common Names of South African Plants ".

His activities on behalf of science were not entirely confined to botany: he was Fellow of the Royal Society of South Africa and of the Linnean Society of London, a Member of the South African Association for the Advancement of Science and the South African Biological Society. He served on the Council of the South African Association for the Advancement of Science for many years and was an efficient secretary and recorder of numerous congresses; in 1930 he was President of Section C and delivered an address entitled " The development of botanical science in South Africa ".

In 1935 he was awarded the South Africa Medal and Grant by the Council of the Association, becoming President in 1942; his address on this occasion was " The advancement of science ". He was an active member of the South African Biological Society holding the position of Honorary Secretary for a record period of 25 years, being elected President and awarded the Senior Captain Scott Medal in 1925.

When the centenary meeting of the British Association for the Advancement of Science took place in London in 1931, he was one of the delegates chosen to represent South Africa. He visited the U.S.A. and Canada in 1934 under the Visitors' Grant Committee of the Carnegie Corporation of New York. A Report on his visit, " Herbaria and botanical institutions in the United States of America and Canada in relation to similar institutions in South Africa ", was published in the South African Biological Pamphlet 8, 1935.

" Life and Living, A Story for Children ". This small book published in 1933 was for the teaching of biology in schools.

Apart from his official and scientific interests, he devoted time to the welfare of the Public Service and the Public Servants Association in particular. He became a member of the Executive Committee of the Association in 1920 and served continuously until 1944, when he was appointed Research Officer to the Public Service Commission. He was Chairman of the Public Servants Association from

1935–36, and President from 1936–38, and Chairman of the Committee appointed by the Public Service Commission to investigate a medical benefit scheme for public servants. In local affairs he was a member and later Chairman of the Pretoria Technical College for many years, and in 1940 was President of the Association of Technical Colleges.

In 1946 he was appointed Scientific Liaison Officer for the Council for Scientific and Industrial Research and stationed at Washington, D.C. Shortly before his return to South Africa in 1948 he sustained the loss of his wife.

As recreation, when nearing his fifties, he joined a local Bowling Club, became President and had the rare distinction of honorary life membership in recognition of his services to the Club.

He married again in 1949, his second wife being Miss Susan Kriel of Pretoria with whom he had worked for many years in the interests of the Public Service. In 1950 he commemorated her name in the Composite genus *Susanna*. She predeceased him in 1965. He spent his remaining days in the home of his younger married daughter in Cape Town. His health rapidly deteriorated and he suffered several slight strokes before his death.

All his long life he had enjoyed good health and had a great capacity for work without fatigue. He had been associated with Dr. Marloth in his early days at the Cape and also later when Marloth was a committee member of the Botanical Survey. He wrote two years before his death: " I owe much to Marloth. He was a tireless worker and one day he said to me: Phillips, if you want to succeed in science, you must work twenty-four hours a day ". Marloth's words must have stimulated him throughout his working days. E. P. Phillips was conscientious, methodical and all his dealings had the stamp of integrity.

Bothalia 10, 1: 5–17

The South African Species of Myrica

by

D. J. B. Killick

ABSTRACT

The South African species of *Myrica* are revised, the 19 species previously recognized being reduced to 9. One variety is elevated to specific rank, viz. *M. conifera* Burm.f. var. *integra* A. Chev. becomes *M.* **integra** (A. Chev.) Killick.

The only comprehensive revision of *Myrica* ever undertaken is that by Chevalier in his Monogr. Myric. (1901). Since that time a mass of material of *Myrica* has accumulated in various herbaria and identification using Chevalier's species-criteria has become increasingly difficult. Adamson (1950) writes: "A genus much in need of revision. There is much uniformity in floral structure and the specific distinctions are based almost wholly upon vegetative characters. Several species exhibit variation in leaf characters in relation to age, habitat or as the result of fires or other forms of interference. Hybridisation almost certainly occurs whenever species are associated ". It is clear, therefore, that a modern revision has become both necessary and urgent.

According to Chevalier the South African Myricaceae belong to the section Cerophora and the subsection Africanae. Chevalier described ten new varieties and five new species from South Africa, viz. *M. incisa*, *M. dregeana*, *M. myrtifolia*, *M. glabrissima* and *M. elliptica*, very often basing his new taxa on single specimens.

The next treatment of *Myrica* was by Hutchinson in Flora Capensis (1925). Hutchinson accepted Chevalier's delimitation of species, except that he sunk *M. natalensis* C.DC. under *M. conifera* Burm.f. Also, he omitted *M. pilulifera* Rendle which, at that time, was considered to be entirely a tropical species.

In the present revision, the 17 species recognized by Chevalier plus the two species subsequently described by Burtt Davy, *M. mossii* and *M. rogersii*, are reduced to nine species.

In spite of Adamson's remarks concerning the uniformity of floral structure in *Myrica*, all the species were carefully dissected, but unfortunately no significant differences between species were revealed. This meant that as in the past the key had to be based almost entirely on vegetative characters.

Type and other specimens were kindly lent or photographs thereof given to the author by the following institutions: BOL, CN, G, M, NBG, P and SAM. Material at the BM, K and LINN was consulted when the author was stationed at Kew between 1954 and 1957.

MYRICA

Myrica *L.*, Sp. Pl. ed. 1, 1024 (1753); Gen. Pl. ed. 5: 449 (1754); Benth. & Hook.f., Gen. Pl. 3, 1: 400 (1880); C.DC. in DC., Prodr. 16, 2: 147 (1864); A. Chev., Monogr. Myric. 139 (1901); Hutch. in Fl. Trop. Afr. 6, 2: 307 (1917); Fl. Cap. 5, 2: 561 (1925); Adamson in Fl. Cape Penins. 311 (1950); Phill., Gen. ed. 2: 245 (1951). Type species: *M. gale* L.

Gale Duham., Trait. Arb. Arbust. 1: 253 (1755); A. Chev., l.c. 92 (1901).

Trees or shrubs, frequently aromatic. *Leaves* alternate, penninerved, entire, serrate, dentate or pinnately lobed; stipules 0. *Flowers* usually dioecious in bracteate spikes; male spikes axillary, solitary, usually densely flowered; female spikes axillary, longer or shorter than the male spikes. *Perianth* 0. *Male flowers* subtended by a solitary bract; stamens 2-many; filaments short, more or less cohering; anthers erect, oblong, with 2 parallel longitudinally dehiscing cells, sometimes papillose. *Female flowers* subtended by a solitary bract and with a whorl of hypogynous scales. *Ovary* sessile, 1-celled; style short, with 2 spreading or ascending branches, filiform or sometimes flattened; ovule 1, erect from the base of the cell, orthotropous. *Drupe* small, globose or ovoid, usually warted and covered with white wax; endocarp hard. *Seed* erect; testa membranous; albumen 0; embryo straight with planoconvex fleshy cotyledons and a short radicle.

A genus of about 56 species, distributed throughout the Northern Hemisphere, 6 in the Mascarenes, 11 in Tropical Africa (*fide* Hutchinson, *l.c.* 562) and 9 in South Africa.

The name *Myrica* is derived from the Greek, *muron*, a scent.

Leaves narrowly attenuate at base:
  Leaves 5–10 cm long:
    Leaves reticulate and not usually gland-dotted .... 1. *M. integra*
    Leaves smooth (not reticulate), but gland-dotted .... 2. *M. serrata*
  Leaves 3–5 cm long:
    Leaves usually pinnately lobed (oak-like) .... 3. *M. quercifolia*
    Leaves elliptic to obovate and margins repand-serrate .... 4. *M. diversifolia*

Leaves broadly cuneate to round at base:
  Leaves distinctly petiolate and blade 3·2–6·5 cm long .... 5. *M. pilulifera*
  Leaves shortly or scarcely petiolate and blade 0·6–4·5 cm long:
    Leaves narrowly elliptic or cordate and less than 3 cm long:
      Leaves narrowly elliptic .... 6. *M. brevifolia*
      Leaves cordate .... 7. *M. cordifolia*
    Leaves elliptic-ovate to broadly ovate and usually longer than 3 cm:
      Male spikes robust and female spikes up to 8 cm long .... 8. *M. kraussiana*
      Male spikes not robust and female spikes up to 4 cm long .... 9. *M. humilis*

1. **Myrica integra** (*A. Chev.*) *Killick*, stat. nov. Type: Clanwilliam, Olifantsrivier, Blackfontein, *Schlechter* 8026 (P, holo.!; PRE!).

M. conifera Burm.f. var. *integra* A. Chev., Monogr. Myric. 148 (1901).

M. linearis sensu A. Chev., l.c. 148 (1901); Hutch. in Fl. Cap. 5, 2: 568–569 (1925).

Tree or shrub, 2–3 m high. *Bark* grey or black. *Ultimate branches* glabrous to pubescent. *Leaves* narrowly elliptic, 6–8 cm long, 0·8–1·5 cm wide, apex acute, base narrowly cuneate, margin usually entire, sometimes remotely serrate, midrib prominent below lateral veins fairly conspicuous, 20–25 at obtuse angle to midrib, surface finely reticulate, eglandular, glabrous, coriaceous; petiole 0·5–1·2 cm long. *Flowers* dioecious. *Male spikes* axillary, solitary, 0·8–1·3 cm long; rhachis not visible; bracts solitary, broadly ovate to broadly trullate, 1–1·5 mm long, 1·5–2 mm wide, deeply concave on inner surface, ridged, ciliate; stamens 4; anthers 1·2 mm long, papillose. *Female spikes* 0·8–1·2 cm long; rhachis scarcely visible; bracts solitary, ovate to broadly ovate-trullate, 1·2–1·5 mm long, 1·4–3 mm wide, ciliate; hypogynous scales 4, roughly ovate, 0·4–0·8 mm diam., keeled, fleshy; style branches 2, filiform or flattened, 1·8 mm long. *Fruits* globose, ±3 mm diam., warted, covered with white wax. FIG. 1: 1.

This species is restricted to an area between Clanwilliam and Stellenbosch in the S.W. Cape, where it is found on riverbanks.

CAPE.—Ceres: Mitchells Pass, *Esterhuysen* 15220; Wittelskloof, *Esterhuysen* 14735; 15220 (BOL). Clanwilliam: rocky stream flowing into Olifants River, *Esterhuysen* 14960 (BOL); bank of Jan Diesels River, *Pillans* 9883; *Schlechter* 916, 8026. Paarl: between Paarl and Lady Grey railway bridge, *Drege* s.n.; Donkerkloof, *Esterhuysen* 15177 (BOL); near river Dutoitskloof, *Marloth* 604; Wemmershoek, *Smuts* 1124. Stellenbosch: Diep Gat Ravine, *Pillans* 18276 (BOL). Worcester: Bains Kloof, *Compton* 13881 (BOL, NBG); *Lewis* 1895 (SAM).

M. integra is very closely allied to *M. serrata* and can really only be distinguished by the conspicuous reticulations on both surfaces of the leaf. Also, it is not usually gland-dotted whereas *M. serrata* invariably is.

Up till now this species has been called *M. linearis*, but it is impossible to establish the identity of *M. linearis* with any certainty. C. de Candolle in his original description of *M. linearis* in DC., Prodr. 16, 2: 154 (1864) states "*Arbuscula patria ignota* (*in herb. Candolle et Kew*)". A search for the type(s) in both the herbaria mentioned failed to reveal their presence in these institutions. At Kew there are three specimens in the type cover of *M. linearis*, viz. *Zeyher* s.n., 76·6 and *Marloth* 604—the two former from Clanwilliam and the last-named from Dutoitskloof. For obvious reasons these specimens cannot be regarded as type material.

One way out of this predicament would have been to select a neo-type for *M. linearis*. This might have been justified if the description of *M. linearis* exactly fitted the accepted concept of the species. However, it does not: while the description emphasizes the prominent secondary nerves of the leaves, which is a diagnostic feature of the species, it falls short in describing the petioles as short and the branches as glabrous.

In view of the above, it was decided to reject the name *M. linearis* and to adopt the combination *M. integra* (A. Chev.) Killick (=*M. conifera* Burm.f. var. *integra* A. Chev.

2. **Myrica serrata** *Lam.*, Encycl. 2: 593 (1786); Killick in Bothalia 8, 2: 175 (1964). Type: Africa, *Sonnerat* s.n. (or 708?) (P, holo.; PRE, photo.).

M. aethiopica L., Mant. Alt. 298 (1771), nom. illegit., pro parte, quoad spec. in Herb. Linn. tantum. Type: C.B.S. (LINN 1169·4). *M. banksifolia* Wendland, Coll. Pl. 1: 70, t.24 (1808). Type: t.24. *M. natalensis* C.DC. in DC., Prodr. 16, 2: 148 (1864); A. Chev., Monogr. Myric. 149–150 (1901). Type: Natal, *Gueinzius* (G, holo.!; PRE, photo.). *M. conifera* auct. non Burm.f., Prodr. Cape. 31 (1768); A. Chev., l.c. 144; Hutch. in Fl. Trop. Afr. 6, 2: 314 (1917); Fl. Cap. 5, 2: 571–572 (1925); Adamson in Fl. Cape Penins. 313–314 (1950). ——var. *banksifolia* (Wendl.) A. Chev., l.c. 147. ——var. *glabra* A. Chev., l.c. 147–148. Syntypes: several, from Port Natal and Cape, *Drege* s.n. (G), *Drege* no. f. (G), *Verreaux* s.n. (G); *Zeyher* 306, 3847 (P), *Boivin* s.n. (P). ——var. *tomentosa* A. Chev., l.c. 147. Type: Africa merid., *Wallich* s.n. (G, holo.!; PRE, photo.). *M. mossii* Burtt Davy, in J.S. Afr. Bot. 4: 123 (1938). Syntypes: Krugersdorp, Witpoortjie Kloof, *Moss* 6653, 6828 (BM!; K!).

Tree or shrub, up to 6 m high. *Bark* brown to black. *Ultimate branches* glabrous to tomentulose. *Leaves* narrowly elliptic, 4·5–10 cm long, 0·6–1·8 mm wide, apex acute, base long attenuate into petiole; petiole 1 cm long; margin entire or remotely serrate with teeth sometimes recurved, midrib prominent especially below, 12–18 subimmersed veins, glabrous to pubescent, lower surface usually conspicuously gland-dotted. *Flowers* monoecious or dioecious. *Male spikes* 0·8–3 cm long; rhachis not or completely visible, glabrous or puberulous; bracts solitary, variable in shape, trullate to very broadly ovate, concave on inner surface, ridged, membranous at edge, ciliate, gland-dotted; stamens 4, sometimes branched at two levels; anthers 1·3 mm long, papillose or epapillose. *Female spikes* 1·2–2·6 mm long; rhachis visible, tomentulose, glandular; bracts ovate, 1·5 mm long, 1·8 mm wide, ciliate, gland-dotted; hypogynous scales 3–5, ovate-triangular, 0·5 mm diam., fleshy, ciliate; style branches filiform to slightly flattened, 2 mm long. *Fruits* globose, c.2 mm diam., warted, covered with white wax. FIG. 1: 2. PLATE 1.

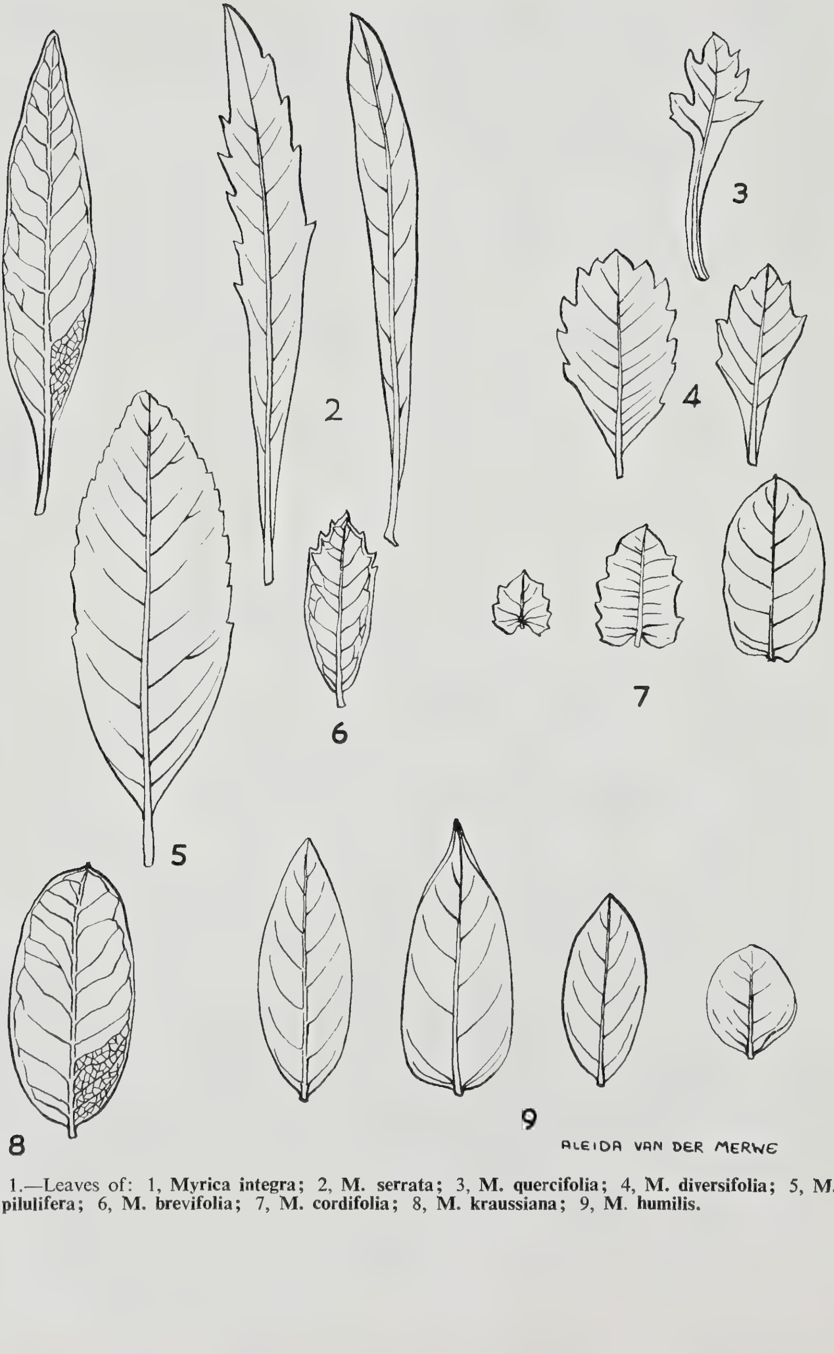

FIG. 1.—Leaves of: 1, **Myrica integra**; 2, **M. serrata**; 3, **M. quercifolia**; 4, **M. diversifolia**; 5, **M. pilulifera**; 6, **M. brevifolia**; 7, **M. cordifolia**; 8, **M. kraussiana**; 9, **M. humilis.**

A streambank species recorded in all provinces of the Republic except the Orange Free State (though probably occurring there) and extending into Lesotho, South West Africa and tropical Africa.

CAPE.—Albany: Beggars Bush, *Archibald* 5967; Howieson's Poort, *Britten* 968; outskirts of Grahamstown, *Britten* 2176; Signal Hill, Grahamstown, *Galpin* 2921; nature reserve, Grahamstown, *Martin* 4639; Slaaikraal, *Mauve & Wells* 20. Alexandria: Zuurberg Range, *Archibald* 3931; Kanitra River Valley, *Archibald* 5767. Caledon: Kleinmond, *Isaac* s.n.; Houwhoek, *Schlechter* s.n. Ceres: Zandfontein, *Compton* 19447 (SAM). Clanwilliam: Brakfontyn, *Zeyher* sub SAM 20279 (SAM). Humansdorp: Assegaaibosch, *Esterhuysen* 6723; Slang River, *Phillips* 3434. Kentani: along streams, *Pegler* 883. King William's Town: Hogsback mountains, *Rattray* 302 (BOL). Knysna: Harkerville Plantation, *Keet* 468. Komga: along streams, *Flanagan* 339. Ladismith: Buffelskloof, *Esterhuysen* 18562; 18564 (BOL). Laingsburg: Witteberg Kloof, *Compton* 3010 (BOL). Lusikisiki: Ntabene, *Fraser* sub Schonland 3747a; Egossa, *Sim* 2520 (BOL). Mossel Bay: Mossel River, *Potts* 1658 (SAM). Mount Currie: Glengarry area, *Killick* 2229. Paarl: Dutoitskloof, *Esterhuysen* 11539; Donkerkloof, Great Drakenstein, *Esterhuysen* 15177; base of Klein Drakenstein near Salem, *Galpin* 11040; French Hoek Forest Reserve, *Leighton* s.n. Peninsula: Brightwater swamp, *Compton* s.n.; Buffelsbay, *Compton* 13070 (NBG); Clifton *Marloth* 3432. Port Elizabeth: Van Staadens, *Drege* sub Marloth 5594; Winterhoek Mountains, *Weimarck* 939; *Sim* Q.11. Riversdale: *Muir* 2819. Somerset East: Zuurberg, *Holland* 153. Stellenbosch: Swartboskloof, *Van der Merwe* 24.24. Stockenstroom: *Acocks* 11108. Stutterheim: Fort Cunynghame, *Sim* 2029. Swellendam: Zuurbraak, *Schlechter* 2128. Tulbagh: near Tulbagh waterfall, *Isaac* s.n.; *Ecklon* 42. Uitenhage: Zwartkops River, *Zeyher* 128; 3876 (BOL). Umzimkulu: Clydesdale, *Tyson* 2556 (SAM). Uniondale: Joubertina, *Esterhuysen* 6919. Victoria East: Hogsback, *Rattray* 303; 1279. Willowmore: *Taylor* 396 (NBG). Worcester: Hex River, near De Doorns, *Bolus* 11948.

NATAL.—Bergville: Mahai River Valley, *Galpin* 9496; Mont-aux-Sources, *Hutchinson, Verdoorn & Forbes* 144; Cathedral Peak Forest Research Station, *Killick* 1650. Eshowe: Umhlatuzi Swamp, *Kotze* 45. Estcourt: stony dolerite koppie, *Acocks* 10493. Hlabisa: St. Lucia Estuary, *Landsdell* 3722; *Pole Evans* 3644. Inanda: *Wood* 985 (SAM). Ingwavuma: Mangusi Forest, *Boocock* (F.D. Herb. 5316). Mtunzini: Ngoye Forest, *Ward* 3468; *Wells & Edwards* 68. Nkandla: Nsuzi River Valley, *Codd* 1423. Pietermaritzburg: Table Mountain, *Killick* 374. Port Shepstone: Shelly Bay, *Mogg* 12742. Ubombo: Mbaswana Forest, *Boocock* (F.D. Herb. 5723); source of Sordwana River, *Michelmore* 38; Lake Sibayi area, *Tinley* 203. Umzinto: Dumisa, *Rudatis* 399. Utrecht: Spieshoek, *Smuts* 1340. Vryheid: Dumuka Mountain, *Gerstner* 45711; Nhlazatsche, *Ward* 3428.

TRANSVAAL.—Barberton: Louws Creek, *Thorncroft* 2046; 4353 (BOL). Bronkhorstspruit: "Spitskop", *Killick* 3460. Krugersdorp: near Hekpoort, *Phillips* 364; Witpoortjie Kloof, *Killick* 3459; *Mogg* 21342; Gladysvale, *Rodin* 3913. Lydenburg: *Wilms* 5835; *Galpin* 12179: 22 miles S.E. of Lydenburg on Nelspruit road, *Marais* 323. Pilgrim's Rest: Bushbuckridge River, *Smuts* 96; 46 miles from Acornhoek on Graskop road, *Story* 3989. Pretoria: Debbe's Ravine, *Mogg* 15052a; Willows, *Repton* 1695; Garsfontein, *Story* 1229. Rustenburg: "Ananda," *Rose Innes* 208; 236; *Sutton* 888. White River: 15 miles east of Skukuza on lower Sabi Road, *Codd & De Winter* 5050; Pretoriuskop, *Van der Schijff*. Waterberg: Hangklip, *Maguire* 1423 (NBG).

LESOTHO.—Leribe: *Dieterlen* 7043 (SAM).

SOUTH WEST AFRICA.—Okavango: Popa Falls, near Andara, *Maguire* 1679. Caprivi Strip: Singalamwe, *Killick & Leistner* 3234; 3235.

Until recently this species was known as *M. conifera* Burm.f. See Killick in Bothalia 8: 175 (1964) for reasons why this name must be rejected in favour of *M. serrata* Lam.

At first it was thought that *M. mossii* Burtt Davy, described from the Transvaal, could possibly be treated as a variety of *M. serrata*, because of its entire leaves. However, natural populations were discovered which showed all gradations from entire to serrate margins (see Plate 1).

3. **Myrica quercifolia** *L.*, Sp. Pl. ed. 1: 1025 (1753), Lam., Encycl. 2: 593 (1786); Willd., Enum. Pl. Hort. Berol. 2. 1012 (1809); Thunb., Fl. Cap. ed Schult. 159 (1823); Drege, Zwei Pfl. Documente 98, 106, 132 (1843); C.DC. in DC., Prodr. 16, 2: 148 (1864); A. Chev., Monogr. Myric. 161 (1901); Marloth, Fl. S. Afr. 1: t.23, fig. A, 1 & 2 (1913); Hutch. in Fl. Cap. 5, 2: 570–571 (1925); Adamson in Fl. Cape Penins. 313 (1950). Syntypes: "Aethiopica", LINN 1169.6 (lecto.!); LINN 1169.5!

M. hirsuta Mill., Gard. Dict. ed. 8, No. 6 (1768). Type: apparently not in existence. *M. ilicifolia* Burm.f., Fl. Ind. et Prodr. Fl. Cap. 31 (err. typ. 27) (1768). Type: *Burmann* s.n. (G, holo.!; PRE, photo.). *M. laciniata* Willd., Enum. Hort. Berol. 2; 1012 (1809).

Type: not seen. *M. zeyheri* C.DC. in DC., Prodr. 16, 2: 149 (1864). Type: mountain ridges, near Caledon, *Zeyher* 3878 (K, holo.!; SAM!; PRE, photo.). *M. incisa* A. Chev., l.c. 150 (1901). Type: Cape, *Burmann* (G, holo.!; PRE, photo.). *L. quercifolia* L. var. *hirsuta* (Mill.) A. Chev., l.c. 163 (1901). ——var. *ilicifolia* (Mill.) A. Chev., l.c. 165, Pl. 8, D 9, 11, 12 (1901). ——var. *latifolia* A. Chev., l.c. 166 (1901). Syntypes: *Roxburgh* s.n. (G), *Drege*, Myric. 3 (G!; PRE, photo.). ——var. *microphylla* A. Chev., l.c. 163, fig. 20B (1901). Syntypes: prope Devils Peak, Cape Town, *Wilms* 3634 (P, K!), *Boivin* 536 (P). ——var. *multiformis* A. Chev., l.c. 163, fig. 20A, C (1901). Syntypes: dunes près du Cap Recief, à 500 pieds d'alt., *Zeyher* 1557, *Lehmann* 1832, *Boivin* s.n. (all P).

PLATE 1.—**Myrica serrata.** The range in leaf variation (right to left: entire to serrate) from a population of this species on the farm " Spitzkop ", Bronkhorstspruit District, Transvaal (*Killick* 3460).

Low, spreading shrub, 15–60 cm high. *Bark* grey to black. *Ultimate branches* glabrous to tomentulose. *Leaves* spathulate-obovate in outline, usually pinnatisect or coarsely repand-dentate, 3–5 cm long, 0·5–2·5 cm wide, apex acute to obtuse, base long-attenuate, midrib fairly prominent, lateral veins immersed, coriaceous, lower surface and sometimes upper surface conspicuously gland-dotted, usually glabrous. *Flowers* dioecious. *Male spikes* axillary, solitary, 0·5–0·8 cm long; rhachis not visible; bracts very broadly ovate, 1·3 mm long, 1·3–1·8 mm wide, membranous at margin, ciliolate, gland-dotted; stamens 2–4; anthers 1 mm long, papillose. *Female spikes* axillary, solitary, 0·5–1·5 mm long; rhachis scarcely to clearly visible, densely gland-dotted; bracts very broadly ovate, 1·7 mm long, 1·3 mm wide, ciliolate, gland-dotted; hypogynous scales 2 or 4, rhombate, fleshy, ciliolate; style branches filiform, 2·3 mm long. *Fruits* globose, 3–4 mm diam., warted, covered with white wax. FIG. 1: 3.

An extremely variable species occurring between Malmesbury and the mouth of the Kei River in the eastern Cape.

CAPE.—Albany: 9 miles from Kaffirdrift on road to Grahamstown, *Story* 1285. Bredasdorp: valley side at base of mountain, *Gilpin* 11233; near Strandkloof, *Maguire* 63 (NBG); Zoetendalsvlei, in dunes, *Smith* 3097; Brandontein, *Smith* 3122; Ratelsrivier, *Van Breda* 921. Caledon: near Dasbos, *Grobler* 1044; Hermanus location, *Grobler* 1066; near Bath, *Marloth* 7668; Genadendal, *Roser* (15413). Humansdorp: Slang River, *Phillips* 3338. Komga: near the Kei mouth at Redwalls, *Flanagan* 2582. Malmesbury: Hopefield, *Marloth* 482; Mamre, *Pillans* 9253 (BOL). Paarl: Top of Franch Hoek Pass, *Leighton* s.n. Peninsula: Kirstenbosch, *Compton* 8079; *Esterhuysen* 11774; Devils Peak, *Esterhuysen* 7975; Claremont, *Hutchinson* 1; near Brightwater, *Leighton* 444; Cape Flats, *Strey* 655; Wynberg, *Zeyler* 1553; Table Mountain *Zeyler* 1553. Port Elizabeth: *Anthony* 44; near Port Elizabeth, *Fries, Norlindh & Weimarck* 317; Greenbushes, *Long* 690; Theesecombe, near Port Elizabeth, *Long* 996; towards Witteklip, *Rodin* 1017; 6 miles west of Walmer, *Story* 2730; on the downs by Port Elizabeth, *Zeyher* 749; Cape Recife, *Zeyher* 1553. Riversdale: *Muir* 2820. Stellenbosch: Brackenfel, *Häfstrom & Acocks* 376. Helderburg, *Parker* 4102; 4103 (NBG). Uitenhage: Thornhill, *Compton* 23409 (NBG); *Zeyher* 749 (SAM).

4. **Myrica diversifolia** *Adamson* in J. S. Afr. Bot. 10: 128 (1944). Type: Cape Peninsula, Modderdam, *Adamson* 3368, holo. (no material traced); Smitswinkel, *Isaac* s.n. in BOL 22583 (BOL, lecto.!; PRE, photo.); paratypes several, including: Klaasjagersberg, *Adamson* 3325, 3345; Contour Path, Kirstenbosch, *Levyns* 1085 etc. (all CT!.)

Erect shrub, up to 1 cm high. *Bark* grey to black. *Ultimate branches* glabrous to tomentulose. *Leaves* elliptic or obovate, 3–5 cm long, 1·5–2 cm wide, apex acute to somewhat round, base cuneate, margin repand-serrate in upper half with serrations often recurved, glabrous or pubescent, gland-dotted, midrib and lateral veins (8) fairly prominent on lower surface, reticulate. *Flowers* dioecious. *Male spikes* axillary, solitary, 1–2 cm long, rhachis scarcely to not visible, gland-dotted, puberulous: bracts solitary, broadly obtrullate-obovate 1·8 mm long, 1·9 mm wide, ciliolate, gland-dotted; stamens 2; anthers 1·5 mm long, papillose. *Female spikes* axillary, solitary, 2 cm long; rhachis visible, puberulous, gland-dotted; bracts broadly ovate, 1·8 mm long, 1·6 mm wide, ciliolate; hypogynous scales 3, c. ovate, 0·5 mm diam., fleshy, ciliolate; style branches 1·2 mm long, flattened, thick. *Fruits* globose, 3 mm diam., warted, covered with white wax. FIG. 1: 4.

CAPE.—Peninsula: Klaasjagersberg, *Adamson* 3325; 3345 (C.T.); Smitswinkel Flats, *Adamson* 3321 (C.T.); Kirstenbosch, *Compton* 14663; Table Mountain, *Compton* s.n.; Ascension Buttress, *Esterhuysen* 11616 (NBG); Silverstream Buttress, *Esterhuysen* 7652; Grootkop, N.E. slopes, *Esterhuysen* 11405 (BOL); Nursery Buttress *Esterhuysen* 11861 (BOL); *Isaac* s.n. (BOL. 22583); Smitswinkel, *Salter* 8758 (BOL); *Killick* 3828; 3829; 3830; 3831; Modderdam, *Killick* 3832; Contour Path, Kirstenbosch, *Levyns* 1085 (C.T.); Kalk Bay, *Levyns* 1086; 1087; 1088 (C.T.); Silvermine Valley, *Levyns* 1094 (C.T.); *Salter* 8756 (BOL).

Restricted entirely to the Cape Peninsula. It is possible that this species is a hybrid between *M. kraussiana* and *M. quercifolia*. In fact, Adamson, the author of *M. diversifolia*, suggested this to the present author in a personal communication (8th January, 1963). However, in Fl. Cape Peninsula, p. 313, Adamson had previously written that " probable hybrids with *M. humilis*, *M. quercifolia* and *M. zeyheri* have been observed ". Considerable field work is necessary to elucidate this problem finally.

5. **Myrica pilulifera** *Rendle* in Trans. Linn. Soc. ser. 2, 4: 43 (1894); A. Chev., Monogr. Myric. 142 (1901); Engl. Bot. Jahrb. 45: 279; figs. G–H (1911); Hutch. in Fl. Trop. Afr. 6, 2: 311–312 (1917). Type: Malawi, Mount Milanji, *Whyte* s.n. (BM, holo.!; K!, PRE, photo of iso.).

M. pilulifera Rendle var. *puberula* Rendle in J. Bot. 41: 86 (1903). Type: Malawi, *Buchanan* 939 (BM, holo.!; K!, PRE, photo. of iso.). *M. rogersii* Burtt Davy, Fl. Transv. 2: 433 (1932). Type: Lydenburg, Sabie, *Rogers* 23083 (K, holo.!; PRE!). *Rogers* 20319 (PRE, para.!).

FIG. 2.—**Myrica pilulifera.** a, twig with male spikes, natural size; b, male bract, × 10; c, stamens, × 20; d, female spike, × 2; e, female bract, × 12; f, pistil surrounded by hypogynous scales, × 10; g, female hypogynous scales, × 10. (d–g, *Scheepers* 677).

Tree or shrub up to 30 m high with girth up to 30 cm. *Bark* dark brown to black. *Branchlets* often prominently lenticellate, glabrous or tomentulose. *Leaves* narrowly elliptic to elliptic-obovate, 3·2–6·5 cm long, 1·5–2·8 cm wide, apex acute to round, apiculate. base cuneate, margin crenato-serrate in upper $\frac{1}{2}$–$\frac{2}{3}$, midrib prominent particularly on lower surface and sometimes pubescent, lateral nerves subimmersed, 12–15, forming obtuse angle to midrib and usually dividing before reaching margin, puberulous when young, becoming glabrous, coriaceous rarely conspicuously gland-dotted; petioles 8–10 mm long. *Flowers* dioecious. *Male spikes* axillary, solitary, 8–25 mm long; rhachis not or scarcely visible, glabrous or pubescent, gland-dotted; bracts approximately obtrullate, 1·5–2·6 mm long, 2–2·5 mm wide, ciliate, ridged, concave on inner surface, not imbricate; stamens 5–8 in two series; anthers 0·8 mm long, minutely papillose. *Female spikes* axillary, solitary, 1·5–4·5 cm long; rhachis visible, pubescent; bracts 1, caducous, ovate, 1·2–2·8 mm long, 0·8–2 00 mm wide, ciliate; hypogynous scales 4–6, roughly ovate, 0·5–1 mm diam., unequal, fleshy, keeled, ciliate, gland-dotted; style branches 2 (rarely 3), 1–1·5 mm long, flattened. *Fruits* ellipsoid-globose, 4–5 mm diam., warted, usually wax-covered. FIGS. 1: 5; 2.

Found usually at high altitudes in Rhodesia, Malawi, Swaziland and South Africa as far south as the eastern Cape.

CAPE.—Tsolo: Ntywenka, *Miller* B/692. Umtata: south of All Saints Nek, *Acocks* 131812; Baziya Forest Station, *Killick & Marais* 2067.

NATAL.—Bergville: Upper Sinyati River Valley, *Edwards* 850; Ntonjelane, Mnweni area, *Esterhuysen* 14513; Mnweni area, *Esterhuysen* 18653; Cathedral Peak Forest Research Station, *Killick* 1709; 1817. Estcourt: Cathkin area, *Esterhuysen* 7959 (NBG); Ntabamhlope, *West* 205. Ngotshe: Ngome, *Gerstner* 4365; 4868; 4869. Nkandla: Nkandla Forest, *Gerstner* 4604. Pietermaritzburg: Little Zwartkop, *Doidge* s.n. Utrecht: Kaffir Drift, *Thode* A. 246. Vryheid: hill on east side of Zungeni Peak. *Acocks* 11501; 11561.

TRANSVAAL.—Barberton: Barberton, *Rogers* 24097; 24897; 8 miles from Havelock mine on Barberton road, *Wells* 2016; kloof on Piggs Peak road, *West* 3008; 3017. Letaba: south face of Piesangskop, *Scheepers* 433; above Grootbos Govt. Forest Reserve, *Scheepers* 677. Lydenburg: Op-de-Berg, *Keet* 1127; 19·3 miles south-east of Lydenburg on Nelspruit road, *Marais* 322. Nelspruit: Kaapsche Hoop, *Strey* 3601. Pietersburg: Blaauwberg, *Esterhuysen* 20496; 21496 (BOL); Rooikoppies, near Politsi siding, *Galpin* 9403; Wolkberg, *Gerstner* 5615; the Downs, *Renny* DE. 14. Pilgrim's Rest: 4 miles west of Graskop, *Codd* 3316; Lulu Mountains, *Mogg* 16932; 46 miles from Acornhoek on Graskop road, *Story* 3993; Mariepskop, *Van der Schijff* 4757; 5566; 5614. Rustenburg: in the "kloof", *Galpin* 11640; 3 miles south of Breedts Nek, *Story* 958. Soutpansberg: Entabeni Forest Reserve, *Codd* 3054; south of Franz Hoek Peak, *Galpin* s.n. (PRE No. 14902).

SWAZILAND.—Mbabane: Gobolo, *Compton* s.n.; near Umsindusi Bush, *Dlamini* s.n. Piggs Peak: Havelock, *Compton* 29138; *Miller* 6042.

The var. *puberula* has not been upheld, because the species is very variable as regards pubescence: populations have been studied in the field which contain both glabrous and puberulous forms.

M. rogersii is quite clearly a synonym of *M. pilulifera*. The latter was probably overlooked by Burtt Davy, because at that time it was known only from tropical Africa.

6. **Myrica brevifolia** *E. Mey. ex C.DC.* in DC., Prodr. 16, 2: 150 (1864); A. Chev., Monogr. Myric. 158 (1901); Hutch. in Fl. Cap. 5, 2: 567 (1925). Type: Queenstown, Winterberg Range, *Zeyher* 5 (K, holo.!; SAM!; PRE, photo. of iso.).

Dwarf shrub with erect stems up to 1 m high arising from underground rootstock. *Bark* dark grey to black. *Ultimate branches* puberulous to tomentulose. *Leaves* narrowly elliptic, occasionally obovate, 1·5–3 cm long, 0·5–1·3 cm wide, apex acute, apiculate, base cuneate to round, margin with 1–5 serrations in upper $\frac{1}{4}$, midrib distinct, lateral veins 4–8, subimmersed or immersed, forming obtuse angle to midrib, glabrous or pubescent, conspicuously glandular, coriaceous, petiole 2–4 mm long. *Flowers* dioecious. *Male spikes* axillary, solitary, 7–12 mm long; rhachis not visible, puberulous; bracts more or less imbricate, trullate-triangular, 1·6–1·7 mm long, 1·8–3 mm wide

ciliate, deeply concave on inner surface; stamens usually 2 but occasionally 4; anthers 0·5 mm long, epapillose. *Female spikes* axillary, solitary, 0·5–1·2 cm long; rhachis not or scarcely visible, pubescent; bracts 1, ovate, 1·6 mm long, 1·5 mm wide, ciliolate; hypogynous scales 4, roughly ovate, 0·5–0·8 mm diam., unequal, fleshy, keeled, style branches 2, 1 mm long, filiform (but slightly flattened). *Fruits* globose, 2–3 mm diam., warted, wax-covered. FIG. 1: 6.

A dwarf species with an underground rootstock which is confined to hills or mountains in Natal and the eastern Cape. Hutchinson in Fl. Cap. 5: 567 (1925) cites a specimen from the Transvaal, viz. *Worsdell* s.n. from Belford, but this specimen cannot be traced.

CAPE.—Adelaide: Winterberg, *Ecklon & Zeyher* 13·6. Albany: Tunnel Hill near Grahamstown, *Davies* s.n.; Grahamstown Nature Reserve, *Story* 2819; *Wells* 3867; 3869. Herschel: Sterkspruit, *Hepburn* 33 (GRA). Humasndorp: MacPeak, *Taylor* 928 (NBG). Keiskammahoek: Cata, *Acocks* 15729; Hogsback Mountain, *Rattray* 330 (BOL); 408 (GRA). Komga: among rocks near Komga, *Flanagan* 93. Queenstown: *Zeyher* 20271 (SAM). Somerset East: summit of Boschberg, *Macowan* 1925. Stockenstroom: Katberg Pass, *Acocks* 12135. Stutterheim: summit of Dohne Peak, *Galpin* 2458.

NATAL.—Bergville: Mnweni, *Esterhuysen* 15547. Pietermaritzburg: Little Zwartkop, *Doidge* s.n. Underberg: top of rocky hills, Himeville, *Bews* s.n. Vryheid: Dumuka Mountain, *Gerstner* 4643.

A note on the type specimen at Kew by Hutchinson reads: " Someone has altered Zeyher to Drege in the Prodomus (Kew copy), but Zeyher's specimen must be the type, because it is female and De Candolle only describes the female ". The reference in the Prodromus does not actually cite No. 5, but does refer to " Zeyher in H. Kew ".

7. **Myrica cordifolia** *L.*, Sp. Pl. 1025 (1753); A. Chev., Monogr. Myric. 168 (1901); Hutch. in Fl. Cap. 5, 2: 563–564 (1925); Adamson & Salter, Fl. Cape Penins. 312 (1950). Syntypes: Cape, LINN 1169.7 (lecto.!); LINN 1169.8!

M. cordifolia L. var. *microphylla* A. Chev., Monogr. Myric. 170 (1901); Hutch., l.c. 564 (1925). Type: Doornhoogde in der Kapfläche, *Ecklon & Zeyher* 78·4 (G: in Herb. Delessert!; P: in Herb. Drake; PRE!). *M. elliptica* A. Chev., l.c. 166. t.8, figs. 1–8 & 10 (1901). Type: Cape, *Burmann* (G, holo!; PRE, photo.).

A much-branched prostrate or erect shrub c. 1 m high (teste *Muir* 176, 3 m high). *Ultimate branches* puberulous to tomentulose. *Leaves* usually imbricate, sessile, broadly ovate to orbicular, 0·6–2·1 cm long, 0·4–1·5 cm wide, apex acute to round, mucronate, base cordate (rarely round or broadly cuneate), margin repand-dentate, glabrous, coriaceous, conspicuously gland-dotted especially below, midrib distinct, prominent below, lateral nerves 4–7 at obtuse angle to midrib, practically immersed. *Flowers* dioecious. *Male spikes* axillary, solitary, 2–5 mm long; rhachis glabrous or puberulous, slightly to fairly visible; bracts solitary, broadly ovate (broadly)-trullate, 1 mm long, 1·2–1·4 mm wide, concave on inner surface, ciliate glandular; stamens 2; anthers 0·5–1 mm long. *Female spikes* 1 cm long; rhachis glabrous, visible; bracts solitary ovate, 1·3–1·7 mm long, 1–1·3 mm wide, ciliate; hypogynous scales 4, roughly ovate, 0·4–0·7 mm diam., fleshy, ciliate, style branches 2, filiform, 0·6 mm long. *Fruits* globose, 0·5–0·8 mm diam., warted, densely covered with wax. FIG. 1: 7.

A common sand-dune shrub extending from the Cape Peninsula to near the mouth of the Kei River in the eastern Cape. The fruits are sometimes melted down and the wax is used as polish or for making candles. The plant is variously known as the Waxberry (Wasbessie), Candle Berry, Vegetable Wax or Glashout.

CAPE.—Alexandria: frequent on secondary dunes, *Archibald* 5022. Bathurst: Kasonga Mouth, *Britten* 2298; Port Alfred, *Hutton* 450; sand slopes of foreshore, Port Alfred, *Tyson* s.n. Bredasdorp: Papkuilsfontein; *Rycroft* 1839 (NBG); Buffelsjacht, *Van Breda* 943. Caledon: Mossel River, Hermanus *Pole Evans* 476; Betty's Bay, *Van Rensburg* 2151. East London: Nahoon River Mouth, *Galpin* 5679; East London, *Sim* s.n. Humansdorp: *Phillips* s.n. Komga: near Kei Mouth, *Flanagan* 1055. Peninsula: Houtbay, *Goulimis* 27256 (BOL); Cape Flats, *Isaac* 27254 (BOL); Schusters Bay, *Isaac* 27233 (BOL); Cape Flats, *Marloth* 8943; Robben Island, *Walgate* 633 (NBG); Uitvlugt, *Wolley*

Dod 2626 (BOL); Houtbay, *Schlechter* 965. Port Elizabeth: Humewood, *Long* 1373; *Sim* 1976. Riversdale: Still Bay, *Muir* 176; 5336; *Van Zinderen Bakker* 299. Simonstown: Fishhoek, near Kalkbay, *Peans* sub Marloth 13511. Somerset West: sand dunes at Strand, *Parker* 3660; 3574 (BOL); Somerset Strand dunes, *Strey* 714. Uitenhage: *Britten* 2084.

M. cordifolia is probably the most clear-cut of the South African species of *Myrica:* because of its characteristic leaf shape it cannot easily be confused with other species.

The type of *M. elliptica, Burmann* s.n., is matched by no other specimen I have seen. It has unequally round bases to the leaves, but otherwise resembles the eastern Cape forms of *M. cordifolia*, e.g. *Flanagan* 1055 etc. Occasionally specimens of *M. cordifolia* have the odd leaf with an unequally round instead of a cordate base. These facts, in my opinion, justify its attachment to *M. cordifolia* rather than its retention as a distinct species.

8. **Myrica kraussiana** *Buching. ex Meisn.* in Flora 6: 89 (1845); A. Chev., Monogr. Myric. 152–153 (1901); Hutch. in Fl. Cap. 6, 2: 566–567 (1925); Adamson in Fl. Cape Penins. 314 (1950). Type: Cape Peninsula, between rocks on summit of Steenberg Mountain, *Krauss* 1564, holo. (no specimens traced); summit of Steenberg Mountain, *Killick* 3456 (PRE, neo.).

M. humilis sensu C.DC. in DC., Prodr. 16, 2: 150 (1864); A. Chev., l.c. 158 (1901); Hutch. in Fl. Cap. 5, 2: 565–566 (1925); Salter in Fl. Cape Penins. 312 (1950), non Cham. & Schlechtd. in Linnaea 6: 535 (1831); *M. kraussiana* Buching. ex Meisn. var. *latifolia* A. Chev., l.c. 153 (1901). Type: Cape, *Harvey* (CN, holo.!; PRE, photo.).

Low shrub. *Bark* brown to black. *Ultimate branches* tomentulose to tomentose. *Leaves* elliptic, 1·5–5·5 cm long, 0·8–3·5 cm wide, apex acute to round, apiculate, base round (rarely somewhat cordate), margin entire to crenatoserrate in upper half, coriaceous, glabrous to densely pubescent, midrib and lateral veins (9–14) prominent on lower surface which is conspicuously reticulate and gland-dotted; petiole 1–3 mm long. *Flowers* dioecious. *Male spikes* axillary, solitary, 1·5–2 cm long; bracts imbricate, trullate-ovate-spathulate-geniculate, large, 3·5–4·5 mm long, 2·5–4 mm wide, concave on inner surface, ciliate, gland-dotted; stamens 4–5; anthers 2·5 mm long, finely and shortly puberulous. *Female spikes* axillary, solitary, 2–8 cm long; rhachis visible, tomentulose; bracts solitary, narrowly ovate, 3–4·8 mm long, 1·7 mm wide, ciliate, gland-dotted; hypogynous scales 5, ovate, 0·5 mm diam., keeled, fleshy; style branches 2, flattened, 2 mm long. *Fruits* subglobose, 2–3 mm diam., warted. Fig. 1: 8.

Chiefly confined to the Cape Peninsula, but extending eastwards as far as Zitzikamma.

Cape.—Caledon: Langkloofberg, *Esterhuysen* 9143 (BOL); Hottentots Holland, *Stokoe* 8949 (BOL). Knysna: Lottering Bush, Zitzikamma, *Galpin* 4581. Peninsula: above Skeleton Gorge, *Esterhuysen* 12015; 12304; Devils Peak, upper slopes, *Esterhuysen* 12941; rocky plateau on Table Mountain, *Esterhuysen* 17563; Groenekloof, *Galpin* 4583; summit of Table Mountain, *Galpin* 4584; summit of Steenberg, *Killick* 3456; *Taylor* 3293; Table Mountain, *Marloth* 1939. Swellendam: slopes of Langebergen, *Esterhuysen* 10481 (BOL); Zuurbraak Mtn., *Galpin* 4582.

Up till now this species has been known as *M. humilis* Cham. & Schlechtd.—probably because the type was never consulted in previous revisions of the genus. The type/s of *M. humilis* is *Bergius, Mund & Maire*. At first it was assumed that this represented one specimen, but on looking through Chamisso and Schlechtendal's descriptions in Linnaea, it became apparent that these authors frequently cited more than one specimen under a collective heading. For example, collectors who were not at the Cape at the same time, are often linked together, e.g. Bergius, Ecklon & Zeyher. After failing to locate a Bergius, Mund and Maire specimen, an isotype of *Mund & Maire* s.n. was received from Geneva (Herb. Boiss.) annotated as *M. humilis* and bearing a type label. Much to the author's surprise this specimen did not represent

our present concept of *M. humilis*, but was actually *M. burmannii*. Moreover, it fitted the original description of *M. humilis* better than what we presently call *M. humilis*. This means that *M. burmannii* is a synonym of *M. humilis* and that what we have been calling *M. burmannii* must now be known as *M. humilis*. It also means that another name must be found for *M. humilis* auct. The only name available is *Myrica kraussiana* Buching. ex Meisn. The type is *Krauss* 1564, but this specimen cannot be traced in any European herbarium. In the original description of *M. kraussiana* the type locality is given as " inter rupes in summitate montium Steenberge, Cap. Sept. Alt. 3,000′ ". In May, 1962, the author visited this mountain and the only *Myrica* found growing there was a somewhat depauperate form of what we have been calling *M. humilis*. In view of this, it seems reasonable to adopt the name *M. kraussiana*. It should be mentioned also that *M. kraussiana* var. *latifolia* clearly equals *M. humilis* auct.

9. **Myrica humilis** *Cham. & Schlechtdl.* in Linnaea 6: 535 (1831); C.DC. in DC., Prodr. 16, 2: 150 (1864); A. Chev., Monogr. Myric. 158 (1901); Hutch. in Fl. Cap. 5, 2: 565–566 (1925). Type: Cape, " *Bergius, Mund & Maire* " (*Mund & Maire*, G, iso.!, PRE, photo.).

M. burmannii E. Mey. ex C.DC. in DC., Prodr. 16, 2: 149 (1864); A. Chev., l.c. 154 (1901); Hutch., l.c. 564–565 (1925); Adamson in Fl. Cape Penins. 312 (1950). Type: Kleyn Rivier, Caledon Division, *Zeyher* 3875 (K, holo.!; PRE!, SAM!). *M. brevifolia* E. Mey. ex C.DC. var. *subintegra* A. Chev. l.c. 160 (1901). Type: *Burmann* 65 (G, holo.; PRE, photo.). *M. dregeana* A. Chev., l.c. 155 (1901); Hutch. l.c. 565 (1925). Type: Van Stadens Berg, Uitenhage Division, *Ecklon & Zeyher* 4·7 (G, holo.!, K!, PRE!, SAM!). *M. glabrissima* A. Chev., l.c. 156–157 (1901). Hutch. l.c., 569 (1925). Type: Long Kloof, about the source of Keurboom's River in a rocky kloof, Mar., George Division, *Burchell* 5081 (P, holo.; K!, PRE, photo. of iso.). *M. myrtifolia* A. Chev., l.c. 155, t.7, fig. A (1901). Type: Cape, specimen ex *Herb. Pet. Thouars* (P, holo.!; PRE, photo.).

Shrub, $\frac{1}{2}$–1 m high. *Bark* pale grey to black. *Ultimate branches* glabrous to tomentulose. *Leaves* elliptic-ovate-broadly ovate (rarely orbicular), 2·5–4·5 cm long, 0·8–2·5 cm wide, apex acute to obtuse, apiculate, base round (occasionally somewhat cuneate), margin entire or with few serrations in upper quarter, midrib fairly prominent, lateral veins 5–10 subimmersed, lower surface reticulate, glabrous, occasionally pubescent on midrib. *Flowers* dioecious. *Male spikes* solitary, axillary, 1–2 cm long; rhachis glabrous to puberulous, scarcely visible; bracts broadly trullate-ovate ridged, concave on inner surface, ciliate, gland-dotted, 1·8–2·8 mm long, 2·3–2·5 mm wide; stamens 4; anthers 1·8 mm long, epapillose. *Female spikes* solitary, axillary, 2·5–4 cm long; rhachis visible, glabrous to tomentulose; bracts broadly ovate, 1·3–1·7 mm long, 1·3–1·75 mm wide, ciliate, gland-dotted; hypogynous scales 4, ovate, 0·5 mm diam., fleshy, ciliate; style branches flattened, thick, long. *Fruit* globose, 4–5 mm diam., warted, covered with white wax. FIG. 1: 9.

A coastal species occurring between the districts of Bredasdorp and Albany.

CAPE.—Albany: near Grahamstown, *Noel* 1323. Bredasdorp: summit of Potberg, *Pillans* 9315. Caledon: Hottentots Holland Mtns. *Stokoe* 7981 (BOL). George: near Touw River, *Burchell* 5739; near George, *Michell* 16094; near George, *Schlechter* 5776; Outeniqua Pass, *Van Breda* 1134. Humansdorp: Flats, Ratelsbosch, *Fourcades* 29; *Thode* A. 1013; Assegaai Bosch, *Thode* A. 2571. Knysna: Lottering Bush, Zitzikama, *Galpin* 4581; *Duthie* 734 (BOL). Melkhoutkraal, *Keet* 555; 556; 3070; 3071. Oudtshoorn: top of Robinson Pass, *Acocks* 20583. Port Elizabeth: Van Stadensberg, *Ecklon & Zeyher* 4·7 (BOL). Riversdale: Aasvoëlbergnek, *Horn* s.n.; Langeberg above Plattekloof, *Muir* 387; Driefontein, Albertinia, *Muir* 959; Langeberg above Nivo, *Muir* 2638; stony flats near Albertinia, *Muir* 4531. Swellendam: slopes in Tradouw Pass, *Marloth* 12163. Uniondale: Kouga Mts., *Esterhuysen* 10784; 10821 (BOL). Uitenhage: Zuurberg Mountain, *Fries, Norlindh & Weimarck* 579.

See discussion under *M. kraussiana* for reasons why this species, known up to now as *M. burmannii*, must be called *M. humilis*.

M. humilis is an extremely variable species as regards leaf shape, size and pubescence. Leaf shape varies from elliptic-ovate to broadly ovate (rarely orbicular) and size from 2·5–4·5 cm long and 0·8–2·5 cm wide. Two species which have been sunk under *M. humilis* represent the extremes in degree of pubescence of this species: *M. glabrissima* is completely glabrous, whereas *M. dregeana* has tomentulose ultimate branches with hairs on the midrib of the leaves. The rolled edges of the leaves of *M. dregeana*, as represented by the type, *Ecklon & Zeyher* 4·7, can probably be attributed to the way in which the specimen was dried rather than to an inherent character of the plant.

M. myrtifola can be linked with *M. humilis* via *Michell* 16094 from George, which serves as a good intermediate.

Species dubia:—

Myrica ovata Wendl. f. in Bartling & Wendland, Beit. zur Botanik, 2: 3 (1825).

The identity of this species is uncertain. The type, *Hesse* s.n., could not be traced: the author tried B, GOET, HAN and S without success.

Bothalia 10, 1: 19–28

The Genus Talinum (Portulacaceae) in Southern Africa

by

H. R. Tölken

Abstract

A revision of the five species of *Talinum* indigenous to South Africa has been undertaken. A key to the species is provided.

Introduction

During a visit to South West Africa observations were made on plants of *Talinum*, but it was very difficult to find correct names for them as seeds were not always available and seed structure is the major key character used. Indeed, the seed characters are very reliable in this genus and the specific patterns of the papillae on the seed membrane can be seen at an early developmental stage. However, specimens without seeds and more specifically male plants of *T. crispatulum* could not be identified. This difficulty, particularly with regard to the four species with yellow flowers which are emphasized in this work, as well as the different interpretations of the species in the literature, indicated the need of taxonomic clarification of the species of this genus.

Further observations in the northern Cape Province convinced me that species can be recognized in the field even without flowers, which open only for a short time in the afternoon. The leaves, although they are very variable, show a few characteristics which may help in identification. For instance, the leaves of *T. crispatulum* have typical crisped leaf margins and are never revolute (see Fig. 1: 3), a combination of characters not found in any of the other species, although young leaves of *T. arnotii* often have a crisped leaf margin. Occasionally specimens of the other three species, especially *T. arnotii*, do not show the revolute leaf margin when grown under particularly humid conditions. The leaves of *T. tenuissimum* and *T. caffrum* are usually linear, but in young plants of *T. caffrum* rather broad leaves are produced and these are so similar to those of *T. arnotii* that flowers and fruits are needed for identification. The leaves of *T. tenuissimum* are always linear and the whole plant is smaller and more delicate than those of *T. caffrum*. Diagnostic characters of these four yellow-flowered species are summarized in Table 1 to illustrate the differences and variation found in this complex. The table will also facilitate the identification of specimens without fruits and/or flowers.

When working on this revision, it was realized that many of the syntypes of species described by Dinter no longer exist at Berlin Herbarium where, according to Lanjouw & Stafleau (1954) in the index of collectors in Index Herbariorum, the original sets of Dinter specimens were deposited. This, and the occurrence of mixed collections found on certain sheets of syntype material seen, made it necessary to select lectotypes. In this connection, specimens from Berlin should get preference as the original set was deposited there and, in addition, Dinter's own herbarium is now in Berlin Herbarium, having been acquired at a more recent date.

TABLE 1.—Summary of differences between *Talinum arnotii*, *T. caffrum*, *T. tenuissimum* and *T. crispatulum*

	T. arnotii	*T. caffrum*	*T. tenuissimum*	*T. crispatulum* male plants	*T. crispatulum* female plants
Flesh of tubers	white becoming reddish-brown	white	reddish-brown	white becoming brown	—
Branches	finely papillose, becoming glabrous	glabrous	glabrous	papillose to hairy	—
Leaves	lanceolate to broadly elliptic (1–) 2–4 (–5) cm long (0·5–) 1–2 (–3) cm broad	linear to oblong, mucronate (1·5–) 2–4 (–8) cm long (0·2–) 0·3–0·6 (–1·2) cm broad	linear (1·5–) 2–4 (–5) cm long 0·1–0·3 (–0·5) cm broad	lanceolate 1–1·5 (–2·5) cm long 0·4–0·6 (–0·8) cm broad	usually broadly lanceolate 1·2–2·5 (–3) cm long 0·6–1 (1·5) cm broad
Leaf margin	revolute, crisped when young; leaf blade recurving	revolute; leaf blade recurving	revolute; leaf blade recurving	crisped; leaf blade never recurved	—
Inflorescence	1–3-flowered	1 (2)-flowered	1–3 (4)-flowered	2–4 (5)-flowered	1 or 2 (3)-flowered
Peduncle	2–3·5 (–4·5) cm long	0·5–1·5 (–2·5) cm long	0·5–1·5 cm long	2–3 (–5) cm long	1–1·5 (–2·5) cm long
Pedicel of lateral flowers	1 or 0 pair of bracteoles	1 or 0 pair of bracteoles	often 2 pairs of bracteoles	2 (3) pairs of bracteoles	1 (2) pairs of bracteoles
Sepals	4–6 (–7) mm long	6–8 (–15) mm long	3–4 (–5) mm long	4–5 mm long	3–4 (–5) mm long
Stamens	20–35 (–50)	25–35 (–50)	8–10 (–14)	20–30 (–35)	numerous staminodes
Style	(2–) 3–4 mm long, swollen below stigma	3–5 mm long, swollen below stigma	1–2 mm long, swollen	—	absent or very short
Ovules	25–40	25–40	10–12 (–15)	—	10–12 (–15)
Seeds	reniform, fine to coarse papillae, often concentric rows	spherical with concentric ridges with papillae between	reniform with elongate papillae radiating out from the hilum	—	reniform with elongate papillae radiating out from the hilum
Habitat	sandy to clayey soils	usually on rock outcrops	sandy soils	sandy soils	—

The author wishes to acknowledge with thanks the loan of specimens from the following herbaria: Albany Museum Herbarium; Herbarium Berlin-Dahlem; Royal Botanic Gardens, Kew; McGregor Museum Herbarium; National Botanic Gardens and South African Museum Herbaria at Kirstenbosch; Natal Herbarium; and Stellenbosch Herbarium.

TALINUM

Talinum *Adanson*, Fam. 2: 245 (1763); Benth. & Hook.f., Gen. Pl. 1: 157 (1862); Oliver in Fl. Trop. Afr. 1: 149 (1868); Sonder in Fl. Cap. 2: 385 (1862); von Poellnitz in Fedde Rep. 35: 1 (1934); Wild in Fl. Zamb. 1, 2: 369 (1961). Type species: *T. triangulare* (Jacq.) Willd.

Shrublets with annual branches from a perennial base, usually tuberous. *Leaves* linear to broadly elliptic, obovate, petiolate, succulent, alternate often irregularly spaced; stipules linear, setaceous, usually keeled, with membranous margin, 1–3 mm long, usually caducous. *Inflorescence* in panicles or axillary, cymose. *Sepals* 2, narrowly ovate to broadly-ovate, keeled, slightly hooded at the apex, green, usually with membranous margin. *Petals* (4) 5 (–7), ovate, pointed or mucronate, often faintly keeled at the apex. *Stamens* 10–30 (–50); filaments usually connate at the base. *Ovary* superior, one-chambered with three carpels, with 10–40 ovules on a free central placenta; style 1–3 mm long or absent; stigmas 3, papillose. *Fruit* a capsule, ovoid to conical, shiny yellow, dehiscing by 3 valves. *Seeds* spherical to reniform, often laterally compressed, with more or less distinct patterns of papillae, dark brown or black.

Species of *Talinum* occur in most parts of Africa, parts of Asia and North and South America. Five species are indigenous in South Africa and occur only in the summer rainfall areas. *T. paniculatum* (Jacq.) Gaertn. from North America is often cultivated and has been recorded a few times as a garden escape, but it does not seem to spread as a weed.

In the African species the pedicels are always swollen below the fruit and are more or less recurved when fruiting.

Leaves obovate, obtuse or rounded at the apex; inflorescence terminal, paniculate, with pink flowers .... 1. *T. portulacifolium*
Leaves linear, broadly elliptic to ovate, tapering towards the apex; inflorescence axillary, cymose, with yellow flowers:
- Leaf margin crisped, never revolute; leaves irregularly alternate with internodes rarely longer than 1 cm, varying in length on the same branch; plant dioecious:
  - Leaves 1–1·5 (–2) cm long, 4–6 (–8) mm broad; anthers with pollen; ovary without ovules .... 4. *T. crispatulum* (male)
  - Leaves 1·5–2·5 (–3) cm long, 6–10 (–15) mm broad; anthers without pollen; ovary with 10–12 ovules .... 4. *T. crispatulum* (female)
- Leaf margin rarely crisped when young, revolute; leaves usually alternate with internodes usually longer than 1 cm and not varying in length on the same branch; plant monoecious:
  - Pedicel thread-like, with (1) 2 pairs of bracteoles; calyx 3–4 mm long; stamens 8–14; seeds 6–12 (–15) per capsule, 2–3 mm long .... 5. *T. tenuissimum*
  - Pedicel not thread-like, with 0 or 1 pair of bracteoles; calyx 5–15 mm long; stamens 20–50; seeds 20–40 per capsule, c. 1 mm long:
    - Inflorescence 1-flowered; seeds with concentric ridges perpendicular, elongate papillae between the ridges; leaves linear to oblong .... 2. *T. caffrum*
    - Inflorescence 1 or 2 (3)-flowered; seeds without ridges, papillose (sometimes arranged in concentric rows, but without elongate papillae between them); leaves narrowly ovate to broadly elliptic .... 3. *T. arnotii*

1. **T. portulacifolium** (*Forsk.*) *Aschers. ex Schweinf.* in Bull. Herb. Boiss. 4, App. 2: 172 (1896); Wild in Fl. Zamb. 1, 2: 372 (1961). Type: Arabia.

Orygia portulacifolia Forsk., Fl. Aegypt.-Arab. 103 (1775).
Portulaca cuneifolia Vahl, Symb. Bot. 1: 33 (1790), nom. illegit. Type: the same as for *O. portulacifolia*.

FIG. 1.—1, **Talinum arnotii,** branch of broad leaved form, × 1 (*Tölken* 1281); 1a, branch of narrow leaved form, × 1 (*Tölken* 1284). 2, **T. caffrum,** branch with flower and fruits, × 1 (*Tölken* 1293). 3, **T. crispatulum,** branch of female plant, × 1 (*Tölken* 1282); 3a, branch of male plant, × 1 (*Tölken* 1283).

Talinum cuneifolium Willd., Sp. Pl. ed. 4, 2: 864 (1800), nom. illegit.; Burtt Davy, Fl. Transv. 1: 166 (1926); von Poellnitz in Fedde Rep. 35: 14 (1934), partly, excl. specimens from S.W.A.

Shrubs with annual glabrous branches up to 1 m high from a perennial base. *Leaves* obovate, obtuse or rounded and mucronate at the apex, cuneate at the base, 2–6 (–10) cm long, 1–3 (–4) cm broad; petiole 1–3 mm long. *Inflorescence* terminal, paniculate, many-flowered, often with leaf-like bracts 5–15 mm long on the main axis, usually with one pair of pointed membranous bracteoles below each flower. *Sepals* broadly ovate, apiculate, 3–4 mm long, slightly keeled at the apex. *Petals* obovate, pointed at the apex, pink or mauve. *Stamens* 25–30 (–35) with terete filaments not connate at the base. *Ovary* spherical with 30–40 ovules; style 2–3 mm long, dividing into 3 stigmas 1–2 mm long, papillose. *Capsule* ovate, 5–8 mm long, 5–6 mm broad, shiny yellow. *Seeds* ovate to reniform, laterally compressed, up to 1 mm long, with indistinct elongate papillae radiating out from the hilum, black.

T. portulacifolium is a shade-loving plant in the northern and eastern Transvaal, but also occurs in most parts of Africa, Arabia and India.

TRANSVAAL.—Letaba: Rooirotse, *Van der Schijff* 3322; Gravelotte, *Van der Merwe* 2323. Messina: Messina, *Rogers* s.n. in BOL 19280 (BOL). Potgietersrus: Soutpan, *Bremekamp & Schweickerdt* 281. Sibasa: Klopperfontein, *Codd* 5417; *Van der Schijff* 3563. Waterberg: 42 miles north of Vaalwater, *Meeuse & Strey* 10454.

The type specimen of this species has not been seen, but Forskal's original description is so complete that there is no doubt as to the species concerned.

2. **T. caffrum** (*Thunb.*) *Eckl. & Zeyh.*, Enum. 282, No. 1802 (1836); Sonder in Fl. Cap. 2: 385 (1862); von Poellnitz in Fedde Rep. 35: 12 (1934), partly, excl. specimens from S.W.A.; Wild in Fl. Zamb. 1, 2: 370 (1961). Type: Cape, *Thunberg* s.n. (UPS, 2 sheets; PRE, photo.!).

Portulaca caffra Thunb., Prod. 85 (1800).

Talinum minus Eckl. & Zeyh., Enum. 282, No. 1803 (1836). Type: Katriviersberg, *Ecklon & Zeyher* s.n. (SAM!). *T. caffrum* var. *minus* (Eckl. & Zeyh.) Sonder in Fl. Cap. 2: 385 (1862). *T. esculentum* Dinter & Schellenberg in Dinter, Veget. Feldkost D.S.W.A. 12 (1912); Fedde Rep. 23: 369 (1927); von Poellnitz in Ber. Bot. Ges. 51: 118 (1933); Fedde Rep. 35: 17 (1934); Podlech in Prodr. Fl. S.W.A. 29: 12 (1967). Type: Otavipforte, *Dinter* 730a (B, lecto.!).

Claytonia caffra (Thunb.) Kuntze, Rev. Gen. 1: 57 (1891).

Plant erect or decumbent; tubers branched, with white flesh. *Branches* glabrous or almost so, 15–25 (–40) cm long. *Leaves* linear to oblong, 2–4 (–8) cm long, (2) 3–6 (–10) mm broad, with margins revolute or recurving; first leaves on branch short and broadly oblong; petiole 1–3 mm long. *Inflorescence* axillary, cymose, 1 (2)-flowered. *Peduncle* 0·5–1·5 (–2·5) cm long, often keeled or laterally compressed, ending in two keeled bracts with membranous margins. *Pedicel* 1–1·5 (–2) cm long, swollen, often ridged below the ovary; bracteoles usually absent, rarely one lateral flower with one pair of bracteoles. *Sepals* lanceolate, pointed, 5–8 (–15) mm long, keeled, slightly hooded, with membranous margins. *Petals* 5, obovate to elliptic, yellow. *Stamens* 25–30 (–50), with filaments becoming broader towards the base, fused into a ring c. 1 mm high. *Ovary* conical, with 25–35 (–40) ovules; style 2–3 (–4) mm long, dividing into 3 stigmas 2 mm long, papillose. *Capsule* ovoid, 6–10 mm long, 6–7 mm broad, shiny, yellow. *Seeds* spherical to comma-shaped, hardly laterally compressed, c. 1 mm long, with ridges with perpendicular grooves between the ridges, dark brown or black. FIG. 1: 2.

This species occurs mainly on rocky outcrops and has mainly an eastern distribution in Africa from the eastern Cape to Kenya, but also extends across Rhodesia and Zambia into north-eastern South West Africa.

Cape.—Albany: Glen Boyd, *Linstaedt* 47. Aliwal North: Elandshoek, *F. Bolus* 156. Beaufort West: 20 miles east of Beaufort West, *Adamson* D 176. Bedford: Eastpoort, *Burtt Davy* 12219; Bedford, *Glane* 130 (GRA). Cathcart: Klipplaatrivier, *Ecklon & Zeyher* s.n. (SAM). Cradock: Mortimer, *Kensit* s.n. (BOL). De Aar: De Aar, *Lander* s.n. (GRA). Fort Beaufort: Alice, *Barker* 2325 (NBG); Kroomie, *Marloth* 9388. Graaff-Reinet: Ryneveld Pass, *Bolus* 372 (BOL, GRA). Kentani: Maquanauli, *Pegler* 639. Kimberley: on road to Boshof, *Brueckner* 29; 30 miles west of Kimberley, *Tölken & Schlieben* 1162. Komga: near Komga, *Flanagan* 1074. Kuruman: 4 miles south of Olifantshoek, *Tölken & Schlieben* 1181. Middelburg: Grootfontein, *Theron* 360. Port St. Johns: Port St. Johns, *Watt & Brandwijk* 1670. Prieska: Prieska, *Bryant* in STE 18287 (STE). Queenstown: Bongola Poort, *Galpin* 1984. Seymour: Katriviersberg, *Ecklon & Zeyher* s.n. (SAM). Stockenstroom: Stockenstroom, *Dyer* 712. Tarkastad: between Cradock and Tarkastad, *Adamson* D 230. Vryburg: Pitsani, *Cole* in NBG 43756 (NBG). Warrenton: Warrenton, *Adams* 128.

Orange Free State.—Bloemfontein: Bloemfontein, *Pole Evans* H 19634. Boshof: between Boshof and Windsorton, *Burtt Davy* 12447. Fauresmith: Fauresmith, *Smith* 5594; *Verdoorn* 1057; *Henrici* 1953. Jacobsdal: Mauretzfontein, *Esterhuysen* 761 (BOL). Kroonstad: Kroonstad, *Wagener* sub Marloth 13529.

Transvaal.—Barberton: near Edwin Bray Battery, *Galpin* 1178. Bloemhof: Kameelpan, *J. J. Theron* S 469. Brits: Crocodile River, *Zeyher* s.n. (BOL, SAM). Cullinao: Rooikop, *Smuts and Gillett* 2003; 2115. Klerksdorp: Klerksdorp, *Lucy* 2 (GRA). Letaba: Tzaneen, *Rogers* 12411. Lichtenburg: Grasfontein, *Sutton* 385. Lydenburg: Sekukunie, *Barnard* 188. Marico: Zeerust, *Thode* A 1408. Piet Retief: Piet Retief, *Leipoldt* s.n. Pilgrim's Rest: Erasmus Pass, *Killick & Strey* 2519; Mariepskop, *Van der Schijff* 6374. Potchefstroom: Boskop, *Louw* 654; Potchefstroom, *G. C. Theron* 2; *Liebenberg* 1073. Potgietersrus: Potgietersrus, *Bolus* s.n. (BOL). Pretoria: Koedoespoort, *Smith* 1531; Brooklyn, *Mogg* 16046; Doornpoort, *Pole Evans* H 13262. Rustenburg: Rustenburg, *Pegler* 2001. Schweizer Renecke: *Burtt Davy* 12776. Sibasa: Punda Milia, *Van der Schijff* 3595; *Lang* in TRV 32200 (BOL). Vereeniging: Vereeniging Estates, *Phillips* s.n. Warmbaths: Warmbaths, *Burtt Davy* 5341. Waterberg: Mosdene, *Galpin* R 236. White River: 5 miles north of Malelane, *Codd* 5230: near Crocodile River Bridge, *Van der Schijff* 3276.

Natal.—Camperdown: Camperdown, *Franks* sub Wood 11945 (BOL, NH). Eshowe: Umhlatuz. Valley, *Gerstner* in NH 22548 (NH). Estcourt: Estcourt, *Pentz* 494; *West* 502; *Acocks* 11393 (NH)i Hlabisa: Hluhluwe Game Reserve, *Ward* 1755: 15 miles from Mtubatuba to Nongoma, *Strey* 5455. Louwsburg: near Magut, *Gerstner* 2424. Lower Umfolozi: 11 miles south-west of Empangeni, *Codd* 1880. Umzinto: Dumisa, *Rudatis* 2013 (STE).

Lesotho.—Leribe: Thaba Phafiva, *Dieterlen* 701. Maseru: Maseru, *Jacot-Guillarmod* 3212.

Swaziland.—Lubombo: Big Bend, *Compton* 30992 (NBG).

South West Africa.—Grootfontein: Aris-Aukas, *Dinter* 730 (B, SAM); Otavipforte, *Dinter* 730a (B). Otjiwarongo, *Pillans* in BOL 27947 (BOL).

This species has distinctive seeds, but is very variable in vegetative characters, especially the shape and size of the leaves. The broadly oblong leaves of young plants might be confused with those of *T. arnotii*. *T. caffrum*, can, however, be recognized by the presence of more than one flower per inflorescence on a short peduncle, while, in the more tropical areas where it sometimes produces more than one flower, the sepals are longer than 8 mm (see Fig. 1: 2).

Two sheets of this species are present in the Thunberg Herbarium (UPS) and both bear flowers and fruit.

The identity of *T. esculentum* Dinter & Schellenberg (1912) can be recognized from the original description on the basis of the characteristic linear leaves and the white flesh of the tuber, the combination of which applies only to this species. However, no specimens were cited together with this description. Of the specimens cited by Dinter (1927) under this species, two species are in Berlin Herbarium of which *Dinter* 730a is selected as lectotype. This specimen was collected in 1908, added to which it bears a note recording the white flesh of the tuber, thus providing evidence that it is probably one of the specimens on which the original description was based. The second specimen *Dinter* 730 in Berlin Herbarium, belongs to the same species, but on

the sheet of this number in SAM is a mixed collection and seeds of *T.esculentum* and *T. tenuissimum* are present in the capsule. *T. esculentum* is a synonym of *T. caffrum*, but t.42 in Neue und wenig bekannte Pflanzen Deutsch-Südwest-Afrikas appears to be a narrow-leaved form of *T. arnotii*. Several lateral flowers on a long peduncle and the recurved, narrowly ovate leaves are rarely found in *T. caffrum*. From the few specimens seen, it appears that *T. caffrum* is not as common in South West Africa as Dinter (1912) estimated.

3. **T. arnotii** *Hook.f.* in Bot. Mag. t. 6220 (1876); von Poellnitz in Fedde Rep. 35: 13 (1934); Wild in Fl. Zamb. 1, 2: 372 (1961). Type: Bot. Mag. t. 6220. *T. caffrum* sensu Dinter, Veget. Feldkost D.S.W.A. 12 (1912); Fedde Rep. 23: 369 (1927); sensu von Poellnitz in Fedde Rep. 35: 13 (1934), partly, including specimens from S.W.A.; sensu Podlech in Prodr. Fl. S.W.A. 29: 11 (1967). *T. cuneifolium* sensu von Poellnitz in Fedde Rep. 35: 15 (1934), partly, including specimens from S.W.A.; sensu Podlech in Prodr. Fl. S.W.A. 29: 12 (1967).

Shrublet, semi-erect, rarely decumbent; tubers long, branched, usually reddish-brown inside. *Branches* slightly hairy, becoming glabrous, succulent, 30–40 (–60) cm long. *Leaves* narrowly or broadly ovate or elliptic, mucronate, 2–4 (–5) cm long, 0·8–1·5 (–2·5) cm broad, with margins often irregularly recurved, appearing wavy; petiole 2–3 (–4) mm long. *Inflorescence* axillary, cymose, 1–3-flowered. *Peduncle* 2–3 (–4) cm long ending in two keeled bracts with membranous margins. *Pedicel* 0·5–1 cm long, swollen below the ovary, usually with lateral flowers with one pair of bracteoles. *Sepals* 5–6 (7) mm long, ovate, keeled and slightly hooded at the apex, with membranous margin. *Petals* (4) 5, ovate, mucronate, faintly keeled at the apex. *Stamens* 20–30 (–50); filaments slightly broadened towards the base, fused into a ring c. 1 mm high. *Ovary* conical with 25–40 ovules; style 2–3 (–4) mm long dividing into 3 stigmas 2–3 mm long, papillose. *Capsule* ovate, 8–9 mm long, 5–6 mm broad, shiny yellow. *Seeds* reniform, laterally compressed, 0·5–1·5 mm long, with fine elongate papillae or coarse papillae arranged in circular rows, dark brown or black. Fig. 1: 1, 1a.

This species occurs usually in sandy, but often also in clay soils, and is distributed in and around the Kalahari basin and well into the centre of South West Africa.

Cape.—Barkly West: Boetsap, *Brueckner* 1263. Hay: La Dauphine, *Acocks* 227; Foot of Wolkaarskop, *Esterhuysen* 2451 (BOL); Dronfield, *Wilman* in KMG 1934 (KMG). Kimberley; Spytfontein, *Schweickerdt* 1119; near Rivermead Station, *Leistner* 2017; Kimberley, *Compton* 23945 (NBG); 25 miles west of Kimberley, *Tölken & Schlieben* 1160. Kuruman: 4 miles south of Olifantshoek, *Tölken & Schlieben* 1182. Postmasburg: Klipbok, *Repton* 4798. Prieska: Prieska, *Bryant* 567; J. 15. Vryburg: near Vryburg, *Rodin* 3525; 4 miles south of Vryburg, *Brueckner* 1114 (KMG). Warrenton: Warrenton, *Pole Evans* H. 11628.

Orange Free State.—Fauresmith: Roodepoortje, *Henrici* 3033. Jacobsdal: Mauretzfontein, *Esterhuysen* 762 (BOL).

Transvaal.—Groblersdal: Marble Hall, *Marais* 1099. Pietersburg: north of Blauwberg, *Obermeyer, Schweickerdt & Verdoorn* 93. Potgietersrus: Steilloop, *Tölken* 1126b. Thabazimbi : Near Northam, *Tölken* 1280; near Makoppa, *Tölken* 1281; 1284. Soutpansberg: between Salt Pan and Waterpoort, *Obermeyer, Schweickerdt & Verdoorn* 260.

South West Africa.—Bethanien: Aris, *Range* 1280 (SAM). Gobabis: 80 miles west of Gobabis, *De Winter* 2514; Sandfontein, *Gillman* 69 (SAM); Sturmfeld, *Tölken* 1301. Grootfontein: Grootfontein, *Schoenfelder* 310; *Borle* 49. Kaokoveld: 4 miles north of Ohopoho, *De Winter & Leistner* 5259; Kaross-Kamanjab, *Thorne* in SAM 35750 (SAM). Karibib: Okomitundo, *Seydel* 1270. Keetmanshoop: Kraikluft, *Pearson* 8208 (BOL); 8269 (BOL, GRA). Okahandja: Okahandja, *Dinter* 1851 (SAM). Okavango: Runtu, *De Winter* 4043; Nama Pan, *Story* 5256; Gautscha Pan, *Maguire* 2133. Otjiwarongo: Quickborn, *Bradfield* 110. Waterberg, *Liebenberg* 4752. Outjo: Outjo, *Barnard* in SAM 33224 (SAM). Rehoboth: Rehoboth *Fleck* 182 (Z); between Rehoboth and Uhlenhorst, *Wilman* in KMG 463; Büllspoort, *Herre* s.n. (BOL). Warmbad: near Dabaigabis, *Pearson* 4433 (BOL). Windhoek: 4 miles north of Windhoek, *Codd* 5787; Neudamm, *Van Vuuren* 1014; Gameros, *Dinter* 2671b (SAM).

T. arnotii is a very variable species. The leaves vary greatly in shape and size and are crisped along the margin when young. Among specimens of this species seen, two types of seeds were observed. Firstly, plants originating mainly from the northern Cape and southern and central South West Africa produce seeds with fine elongate papillae radiating out from the hilum. These seeds are very similar to those of *T. tenuissimum* and *T. crispatulum*, but are never longer than 1·5 mm. The second form occurs in the northern parts of the Cape Province, Transvaal, Botswana and South West Africa and also in Rhodesia and Zambia. The papillae of the seed membrane are coarse, about as long as broad and arranged in concentric rows. In the northern parts of the distribution of this form, the papillae become less clearly arranged in concentric rows and the seeds are usually less than 1 mm long. In the Transvaal the two forms were found together at two localities (near Thabazimbi *Tölken* 1284, 1281; near Makapanstad, *Tölken* 1278, 1277). The corresponding plants can usually also be distinguished. The plants with finer papillae occur on the more clayey soils and produce narrower leaves and normally one, rarely many, flowers on a long peduncle (see FIG. 1: 1a). The plants with coarse seed papillae occur on sandy soils and have broad leaves usually irregularly reflexed and usually with three flowers per inflorescence (see FIG. 1: 1). However, intermediates to all these characters, except the seed characters, were found in both localities and also in herbarium material. Specimens seen from north-eastern South West Africa and northern Cape also indicate that the two forms apparently occur together in these areas without any definite intermediates. In addition, specimens from the eastern central South West Africa have seeds with fine papillae approaching those of the second type. Specimens with definite intermediate seed characters have not been seen, but in view of insufficient material seen from Botswana, the complex is not thoroughly understood and can thus not be fully evaluated.

4. **T. crispatulum** *Dinter* in Fedde Rep. 23: 369 (1927); von Poellnitz in Ber. Bot. Dt. Ges. 51: 117 (1933); Fedde Rep. 35: 18 (1934); Podlech in Prodr. Fl. S.W.A. 29: 12 (1967); Wild in Fl. Zamb. 1, 2: 372 (1961), as *T. crispatulatum*, partly. Type: Grootfontein: Palmenhain, *Dinter* 2357 (SAM, lecto.!).

Plant dioecious, prostrate or decumbent; tubers branching from the top, with white flesh. *Male plants* with branches 25–40 cm long, little branched, papillose to hairy when young, becoming almost glabrous; internodes rarely longer than 1 cm, varying greatly in length on the same branch. *Leaves* narrowly ovate, 1–1·5 (–2) cm long, 4–6 (–8) mm broad, with margins crisped, never revolute; petiole 1–2 (–3) mm long. *Inflorescence* axillary, 2–4 (–5)-flowered. *Peduncle* 2–3 (–5) cm long, thread-like, ending in two keeled bracts with membranous margin. *Pedicel* 1–1·5 cm long, of the central flower with 0 or 1 pair of bracteoles, of the lateral flowers with (1) 2 (3) pairs of bracteoles. *Sepals* 2–4 (–5) mm long, lanceolate, keeled and slightly hooded at the apex, with membranous margin. *Petals* 5, lanceolate, tapering to the base, yellow. *Stamens* 20–30 (–35); filaments broadened towards the base, fused into a ring c. 1 mm high. *Ovary* almost spherical with no ovules developed; style absent; three stigmas c. 1 mm long, stiff erect, not papillose. *Female plants* with branches 20–30 cm long, branched, papillose to hairy when young becoming almost glabrous; internodes rarely longer than 1 cm, varying in length on the same branch. *Leaves* lanceolate, 1·5–2·5 (–3) cm long, 0·6–1 (–1·5) cm broad, with margins crisped, never revolute; petiole 1–3 (–4) mm long. *Inflorescence* axillary, 1–2 (3)-flowered. *Peduncle* 1–1·5 (–2·5 cm long,) thread-like, ending in two keeled bracts with membranous margin. *Pedicel* 0·5–1·5 cm long, swollen below the ovary, of lateral flowers with 1 (2) pairs of bracteoles. *Sepals* 3–4 (–5) mm long, ovate, keeled and slightly hooded at the apex, with membranous margin. *Petals* 5, ovate, pointed, sometimes uneven, yellow. *Staminodes*

25–30, fine; filaments broadened towards the base, usually fused into a ring. *Ovary* almost spherical with 10–12 ovules; style absent or less than 1 mm long; stigmas 3, 2 (–3) mm long, papillose-plumose. *Capsule* conical, pointed, 5–6 mm long, 3–4 mm broad shiny yellow. *Seeds* reniform, laterally compressed, 2–2·5 mm long, with fine elongate papillae radiating out from the hilum, dark brown or black. FIG. 1: 3, 3a.

This species is common in sandy soils in and around the Kalahari basin.

CAPE.—Barkly West: Newlands, *Esterhuysen* in NBG 5474 (NBG). Hay: Rietkloof, *Acocks* 8552 (BOL, GRA); Bermolli, *Wilman* s.n. (GRA, KMG). Kuruman: Kuruman, *Esterhuysen* 759; 2436 (BOL); Batharos, *Silk* 228 (KMG); 4 miles south of Olifantshoek, *Tölken & Schlieben* 1190; 1191; Cotton End, *Swan* in KMG 5071 (KMG). Postmasburg: Klipbok, *Repton* 4794. Vryburg: between Armadillo Creek and Vergelegen, *Burtt Davy* 11166; Armadillo Creek, *Burtt Davy* 11180.

TRANSVAAL.—Potgietersrus: Steilloop, *Tolken* 1126a. Thabazimbi: near Makoppa, *Tölken* 1282; 1283.

SOUTH WEST AFRICA.—Gobabis: Gobabis, *Dinter* in SAM 74148 (SAM); Sandfontein, *Wilman* in SAM 27105 (SAM); Uitsig, *Merxmüller & Giess* 1105; Sturmfeld, *Tölken* 1302. Grootfontein, Palmenhain, *Dinter* 2357 (SAM). Okavango: east of Karakuwise, *Maguire* 2065 (NBG); Gautscha Pan, *Maguire* 2133 (NBG). Otjiwarongo: Quickborn, *Bradfield* 361.

I do not agree with Podlech that the author of this species should be "Dinter ex von Poellnitz" as the crisped leaves and smaller flowers mentioned in Dinter's diagnosis plus the type cited amount to more than a *nomen nudum* (see Int. Code of Bot. Nomenclature, Article 32, 1966).

Wild (1961) uses the name *T. crispatulatum* consistently, but there seems to be no reason to change the epithet from the originally published version, *T. crispatulum*.

5. **T. tenuissimum** *Dinter*, Neue Pl. D.S.W.A. 55 (1914); Fedde Rep. 23: 369 (1927); von Poellnitz in Fedde Rep. 35: 18 (1934); Podlech in Prodr. Fl. S.W.A. 29: 12 (1967), partly, excluding specimens cited. Type: Kalkfontein–Gobabis, *Dinter* 2725 (B, lecto.!; SAM!). *T. transvaalense* von Poellnitz in Fedde Rep. 35: 34 (1934). Type: Transvaal, Sibasa, Baiandbai, *Lang* in TRV 32199. *T. dinteri* von Poellnitz in Fedde Rep. 35: 32 (1934), nomen subnudum. Type: Jakkalskuppe, *Dinter* 4204 (B, holo.!). *T. crispatulatum* sensu Wild in Fl. Zamb. 1, 2: 372 (1961), partly.

Plant semi-erect or decumbent; tubers rarely longer than 5 cm, rarely branched, with reddish-brown flesh. *Branches* glabrous, 15–20 (–30) cm long. *Leaves* linear, 2–4 (–5) cm long, 2–4 mm broad, margins revolute; petiole 1–2 (–3) mm long. *Inflorescence* axillary, 1–2 (3)-flowered. *Peduncle* 0·4–1·5 mm long, thread-like, ending in two keeled bracts with membranous margin. *Pedicel* 1–2·5 cm long, swollen below the ovary, of central and lateral flowers with (0) 1 or 2 pairs of bracteoles often uneven long. *Sepals* 3–4 mm long, keeled and slightly hooded at the apex. *Petals* 5, oblong, obtuse, mucronate, hardly tapering towards the base, yellow. *Stamens* 8–14; filaments slightly broadened towards the base, not fused into a complete ring. *Ovary* almost spherical with 10–12 ovules; style c. 1 mm long, swollen, dividing into three spreading stigmas c. 1 mm long, papillose. *Capsule* conical, pointed or almost beaked, 6–7 mm long, 3–4 mm broad, shiny yellow. *Seeds* reniform to comma-shaped, much laterally compressed, 2–2·5 mm long with fine elongate papillae radiating out from the hilum, dark brown to black.

T. tenuissimum occurs on sandy Kalahari soils in South Africa, but its distribution extends into Mozambique, Rhodesia, Zambia and Tanzania.

CAPE.—Barkly West: Newlands, *Esterhuysen* 760 (BOL). Gordonia: Tweegesigspan, *Liebenberg* 7049. Hay: Tygerkop, *Wilman* in KMG 2347 (KMG). Kimberley: 4·5 miles from Kimberley to Boshof, *Esterhuysen* 763 (BOL). Kuruman: near Kuruman *Esterhuysen* 2437 (BOL).

TRANSVAAL.—Brits: Welgefonden, *Obermeyer* in TRV 34762. Pietersburg: Swerwerskraal, *Irvine* 110; *Herre* in BOL 27950 (BOL). Sibasa: 28 miles west of Punda Milia, *Lang* in TRV 32199. Soutpansberg: north of Salt Pan, *Schlieben* 9216; *Obermeyer, Schweickerdt & Verdoorn* 193.

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South West Africa.—Bethanien: Kuibis, *Dinter* 1194 (SAM). Gobabis: Gobabis–Kalkfontein, *Dinter* 2725 (B, SAM); Gobabis–Kehopo, *Dinter* in SAM 74153; Babi-Babi, *Wilman* in SAM 27106a (SAM). Lüderitz: Jakkalskuppe, *Dinter* 4204 (B). Okahandja: Okakeva, *Dinter* 3315 (SAM). Okavango: Kapupahedi Camp on Omuramba Omatako, *De Winter & Marais* 4632; Gautscha Pan, *Maguire* 2195 (NBG). Otjiwarongo: Quickborn, *Bradfield* 320B. Rehoboth: Klein Nauas, *Dinter* 1937 (SAM). Windhoek: Gameros, *Dinter* 2671a (B, SAM).

Wild (1961) includes this species under *T. crispatulatum* and his Tab. 71, A1 depicts a plant of typical *T. tenuissimum.* Although the seeds of the two species are very similar, *T. tenuissimum* has flowers with 8–14 stamens and linear leaves with revolute margins. In cultivation (*Dinter* in SAM 74152), the leaves become slightly broader, but they retain their linear shape. In *T. crispatulum* the flowers always produce more than 20 stamens and the narrowly ovate leaves have crisped, never revolute margins.

T. dinteri von Poellnitz, a *nomen subnudum* based on *Dinter* 4204, is very similar to *T. tenuissimum* in that it produces linear leaves, more than one flower per peduncle, c. 12 stamens and 10 ovules. Unusual for *T. tenuissimum* is, however, the single pair of bracteoles on the pedicel, but this character is apparently variable as the absence of additional pairs of bracteoles can also be observed in the specimen *Dinter* 1794 (SAM), a specimen apparently growing under similar unfavourable conditions. This latter specimen, collected on sand dunes in the Bethanien district, provides a link between the distribution as well as the morphology of *Dinter* 4204 and the Kalahari population of *T. tenuissimum.*

The specimen *Pearson* 4162 (K!) collected at Jakkalskuppe confirms the identification of this plant as *T. tenuissimum* as it bears the typical seeds. This specimen is inscribed *T. lissospermum* C. A. Smith MS.

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Bothalia 10, 1: 29–37

A New Species of Raphia from Northern Zululand and Southern Mozambique

by

A. A. Obermeyer and R. G. Strey

Abstract

The Raphia Palm from northern Zululand and southern Mozambique has been known for many years as *Raphia vinifera* Beauv., but an investigation of flowering material revealed that it was distinct from that species and represented a new species, which is here described as *R.* **australis** Oberm. & Strey. In addition to the description, notes on the morphology, history, preservation and uses of the plant are given.

Description

Raphia australis *Oberm. & Strey*, sp. nov., *R. vinifera* Beauv. affinis, sed inflorescentia terminali erecta fructu ellipsoideo squamis convexis leviter sulcatis differt.

Caudex simplex. *Spadix* erectus terminalis spicis fertilibus patentibus tortilibus floribus femineis in dimidio inferiore. *Flos masculus* staminibus 6 liberis conniventibus. *Flos femineus* annulo staminodio dentibus inaequalibus aliquot antheris minutis. *Fructus* ellipsoideus squamis convexis 6-orthostichis leviter sulcatis.

Type: Natal, Ingwavuma District, Kosi Bay area, west of Lake Amanzimnyana, 6·3 miles east of Maputa, edge of dense forest which is inundated in the rainy season, November 1967, *Strey* 7785 (PRE, holo.; NH).

A large unbranched stout tree up to 16 m tall. *Stem* up to 10 m tall, covered with the old persistent adpressed erect leafbases. *Leaves* rosulate, younger erect, outer somewhat spreading, pinnate, up to c. 10 m long; petiole unarmed concave and clasping below; the rhachis narrows into a canaliculate stalk for about two thirds of its length with the two spiny margins unequal in height gradually approaching one another until they merge (the lower ridge disappearing); at this point the leaf bends outwards; the pinnae are inserted on the outside of the marginal ridges, linear, 45–65 cm long, 5 cm broad, folded below, pale green above, waxy below, the margins bearing small sharp ascending pale spinules about 4 mm long, midrib raised with a double row of spinules in the lower half which merge to form a single row above. *Inflorescence* apical, erect, exserted centrally above the crown of leaves, conical, up to 3 m tall, its lowest flowering branches in the axils of the upper leaves; the subsequent leaves (c. 13) subtending the flowering branches, gradually reduced, the uppermost c. 50 cm long; peduncle 11 cm in diam. at the base, covered by 2-ranked, clasping imbricate tubular hard bracts; the basal bract of each branch differing from the following ones in shape; it is 2-pronged like a lobster-claw, flattened and bi-carinate, up to 40 cm long and 6 cm broad; it recurs on all the following side-branches becoming progressively smaller higher up; the subsequent bracts tubular with a truncate apex which forms an acute point, the points arranged alternately from side to side; branches exserted, laterally compressed, sub-4-ranked with 2 side-branches close together on each side of the rhachis, erect at first, patent in fruit, bracts similar to those covering the peduncle but reduced in size; the side branches bearing the numerous abbreviated fertile spikes in close proximity to one

another; their arrangement is also sub-4-ranked with two rows of spikes close together on each side of the laterally compressed rhachis; fertile spikes spreading and twisting, with the unisexual flowers 2-ranked, the female occupying the lower part of the spike, the male the upper part; the apical spikes with male flowers only; the lower spikes up to 40 cm long becoming shorter towards the apex; fertile bracts similar in shape and form to those of the branches but smaller. *Male flowers* surrounded by a bi-carinate bracteole; hiding inside it is a small tubular, truncate calyx and exserted from it a corolla consisting of 3 hard linear-falcate segments which are nearly free to the base, 10 mm long, 2 mm broad, with a triangular, slightly swollen apex; stamens 6, free, filaments connivent, swollen, 4 mm long, 3-angled, apiculate, anthers with parallel linear locules 6 mm long. *Female flowers* surrounded by a bi-carinate bracteole and a second one inside it which is short, tubular and truncate, calyx and corolla enlarging after fruit has set, exserted from the bracteoles; calyx tubular, splitting irregularly into 3 truncate lobes when the ovary enlarges, 8 mm long; corolla segments 3, hard, beaked; staminodial ring adnate to the corolla, flattened, with unequal blunt teeth, some bearing minute anthers; ovary 3-celled, uni-ovulate, with the minute scales fimbriate; stigmas 3, sessile, apical, tongue-shaped, erect, at anthesis exposed through a small apical aperture of the corolla before the latter enlarges. *Fruit* one-seeded, ellipsoid, 6–9 cm long and 3–5 cm in diam. hard, shiny yellow-brown, shortly beaked, the reflexed convex scales arranged in 6 vertical rows, median groove shallow, edges with a short golden fringe of hairs.

R. australis is found in swamp forests near the coast in northern Zululand and southern Mozambique.

NATAL.—Ingwavuma: Kosi Bay area, west of lake Amanzimnyana, 6·3 miles east of Maputa, *Strey* 7785; *Strey* 8200; *De Winter & Vahrmeijer* 8617; Cult: Mtunzini, *Garland* in PRE 30368; Durban Botanic Station, *Strey* 7373; 7800; 8060; 8263.

Dr. Gomes e Sousa in a personal communication, 19th February 1969, reported seeing it in fruit on the Boboli River near Marracuene, 40 km north of Lourenco Marques. It is called " Imali " in Ronga.

In the past 40 years much has been written on the Raphia Palm from Zululand but, owing to its size, no complete collections of the inflorescence (only an occasional nut) or photographs of flowering plants have reached herbaria. It was only when two palms in the garden of the Botanic Station in Durban, which were raised from seed collected by Dr. V. E. Wager at Mtunzini, developed erect inflorescences, that it was realized that we were dealing with an undescribed species. Before this, the Raphia Palm from Zululand was referred to *R. vinifera*, but this species bears pendulous inflorescences in the axils of the leaves and its fruits too, have a different shape.

MORPHOLOGICAL NOTES

Roots.—(*a*) Pneumatophores. Around its base the palm forms negatively geotropic roots up to 10 cm high, exserted above the swampy ground which is flooded seasonally. (*b*) Epigeal rootlets. In the axils of the lower leaves rootlets are developed, which penetrate into the fibrous mass seeking moisture and nutrients. The thickness of this root-mantle around the lower part of the stem may be up to 5 cm in thickness.

Leaves.—About two new leaves are formed annually as observed on the palm growing at the Botanic Station, Durban. The dying old leaves gradually fall down backwards leaving only a short clasping leaf-base c. 60 cm wide below. The rhachis is canaliculate for about two thirds of the way up and the rainwater thus runs into the axils, which are filled with humus and harbour epiphytes such as the ferns *Stenochlaena tenuifolium, Lygodim microphyllum* and *Psilotum nudum.*

Inflorescence.—The lowest branch of the inflorescence measured up to 3 m long and had a circumference of 50 cm at the base. The terminal shaft was estimated to be c. 5 m tall.

Fruits.—About 8–10,000 fruits are developed on an inflorescence. The weight of 50 fruits averaged about 3 lb. Therefore a fruiting inflorescence may weigh between five and six hundred pounds.

Seed.—The yellow spongy integument under the scales is sweet and sticky and attracts the Palm-nut vultures. The structure of the seed and embryo is typical of the family. The small anatropous embryo has the funiculus situated in a groove of the pericarp where the two aborted locules meet. The endosperm is ruminate and the cotyledon forms a haustorium, which extracts the food for the embryo.

Rate of Growth.—The Raphia Palm is said to reach a height of about 40–50 feet in 20–40 years from seed and then flowers and dies after setting fruit. The specimens growing at the Botanic Station in Durban flowered after 24 years. Regeneration from seed is excellent, but nearly always confined to the immediate neighbourhood of the old palms. It does not sucker.

Historical Notes

Some of the early history of the Mtunzini Grove is related in an interesting article by Mr. W. M. Austen, a ranger of the Natal Parks, Game & Preservation Board, in *The Ostrich*, September, 1953, where he described his observations made on Palm-nut Vultures that nest in the Raphia Palm and feed on the fruits. He remembered seeing the Mtunzini Grove in 1915; it was established by the late Mr. C. C. Foxon, who was Magistrate and Native Commissioner at Mtunzini and who had collected the seeds near the Maputa village in Tongaland. It occurs there naturally in the fresh-water swamp-forests at the southern end of the five Kosi lakes, either as isolated trees or forming small groups of about 20 individuals. This swamp-forest type of vegetation is also found further northwards in Mozambique and Portuguese botanists believe that it constitutes the climax vegetation of this area.

Preservation

The palm grove near the Mtunzini Railway Station has been declared a national monument. Solitary individuals or small groups are however found in the neighbourhood; in one grove about thirty individuals were counted. Further north in Tongaland they are not protected.

Uses

The Natives use the old leaf-midribs for hut building and rafts. At the bus terminal at Maputa is a fenced-in market place where market-stalls and communal shelters have been constructed from the leaf-midribs. Rafts are also made for crossing the Sihadla River (see photos). The young leaves are not stripped for raffia as in *R. farinifera*, nor is the sap tapped for making wine as in *R. vinifera* and other species.

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FIG. 1.—**Raphia australis.** 1, flowering spike showing female flowers in lower half and male flowers above, × ½; 2, young female and male flowers, × ½; 3, male flower showing bract (*b*), bracteole (*br*)-calyx (*ca*) and corolla (*co*), × 2; 4, longit. section of male flower showing 2 petals and 3 stamens × 2; 5, female flower showing bract (5), bracteole (6), inner bracteole (7), calyx (8), corolla and staminodial ring (9) and ovary (10), all × 2; 11, longitudinal-section of a young fruit with embryo, × ½; 12, cross-section of a young fruit, × ½; 13, cross-section of ruminate endosperm, × ½; 14, fruit, × ½; 15, 16, 17, 18, cross-sections of the leaf-rhachis at various points from base to top, (the pinnae cut off), × ½; 19, seed, showing two lateral sterile locules and the groove containing the funiculus, × ½; 20, young seedling, cross-section of haustorium and endosperm, × ½; 21, seedling showing remains of yellow integument and pericarp, × ½. 1–10, *Strey* 7373; 11–13, 19, *Strey* 7785; 14, *Garland* in PRE 30368; 15–18, *Strey* 7373; 20–21, *Strey* 7785.

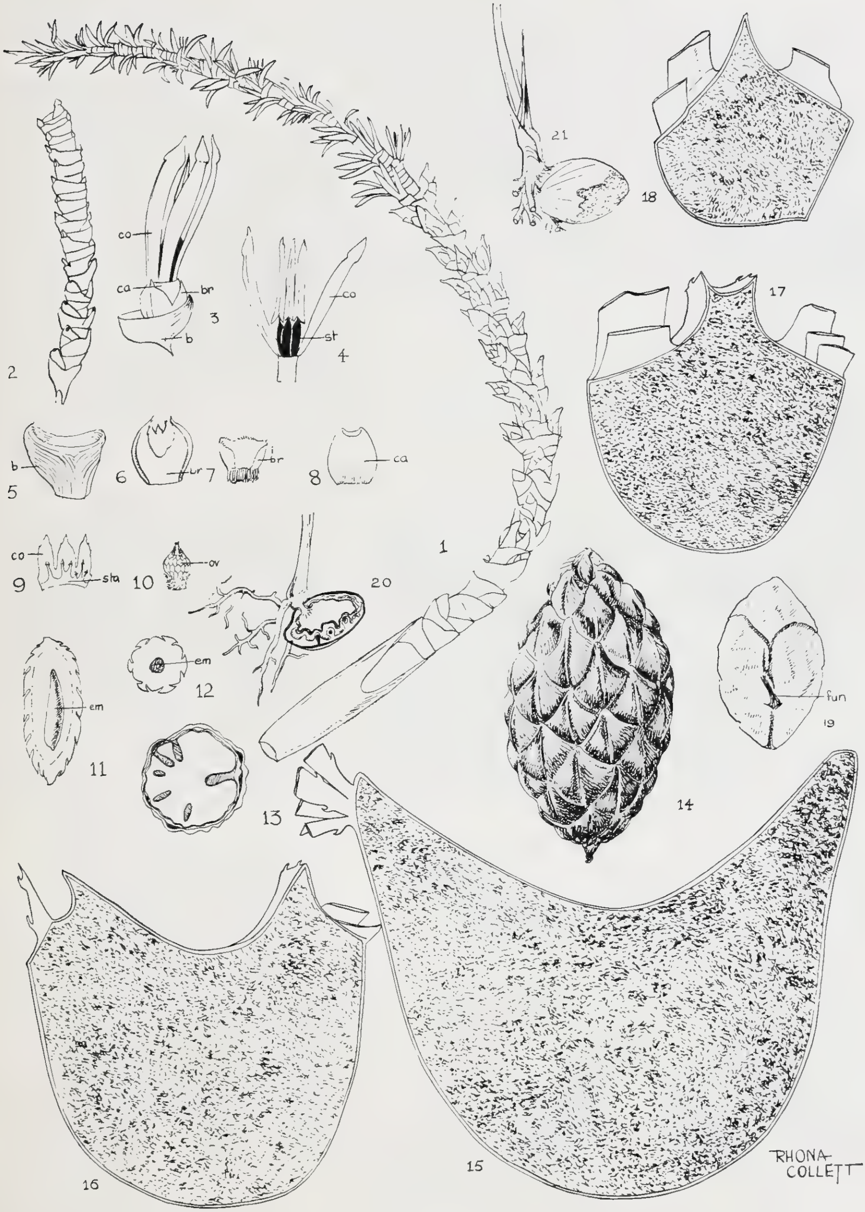
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FIG. 1

PLATE 1.—**Raphia australis.** 1, part of flowering inflorescence, branch of second order. Natal Herbarium garden, 30th May 1967 (*Strey* 7493). 2, same as 1, but lower down showing part bearing female flowers and above male. 3, ripe fruit from Mtunzini Grove, 27th February 1967 (*Garland* in PRE 30368). 4a, ripe fruits showing scales; 4b, inner yellow sticky, sweetish integument; 4c, seed showing 2 aborted carpels and funicle in vertical furrow; 4d, seed cut open showing hard endosperm and resinous intrusions, Lake Amanzimnyana, 20th November 1967 (*Strey* 7785 3879); 5, seedlings showing haustorium, root and shoot, from Lake Amanzimnyana. Photos: 1–3, H. J. Schlieben; 4, 5, R.G. Strey.

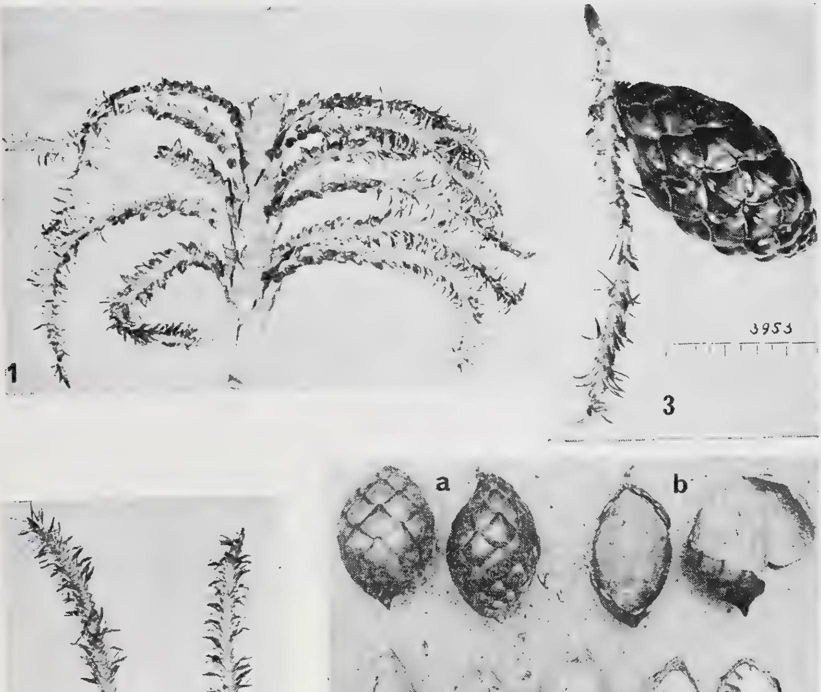

PLATE 1

PLATE 2.—**Raphia australis** in flower in the Natal Herbarium garden Durban, May 1967. Photo: E. J. Moll.

PLATE 3.—Lower part of trunk of palm in Plate 2 with leaf-bases removed to show epigeal roots. March 1967. Photo: R. G. Strey.

PLATE 4.—Flowering tree at Lake Amanzimnyana near Maputa. October 1967. Photo: B. de Winter.

PLATE 5.—Single leaf of a tree from Lake Amanzimnyana. October 1967. Photo: B. de Winter.

PLATE 6.—Grove of Raphia palms growing on the west side of Lake Amanzimnyana. November 1967. Photo: E. J. Moll.

PLATE 7.—Raft built by the Tongas from the midribs of the Raphia leaves. Sihadhla River. Photo: E. J. Moll.

PLATE 8.—Bus terminal and market place, Maputa, showing communal buildings and stalls made of midribs of Raphia leaves. Photo: E. J. Moll.

Bothalia 10, 1: 39–42

The Disc in the Southern African Species of Maerua

by

D. J. B. Killick

Abstract

The six types of disc present in the Southern African species of *Maerua* (Capparaceae) are described and illustrated. A key to the species, based largely on the disc character, is presented.

While working on the genus *Maerua* for the Flora of Southern Africa, the author was struck by the variety of disc forms present in the Southern African species of the genus. Discs of various kinds are present in many genera of the Capparaceae. They are well reviewed by Pax in Engler and Prantl's Naturlichen Pflanzenfamilien, Teil 3, Abt. 2:215–217 (1891) and Pax and Hoffmann, *op.cit.*, Band 17b:156–157 (1936). In *Maerua* the inner margin of the receptacle is produced into a disc, which in many species projects beyond the receptacle as a corona, annulus, lobes or teeth. In this paper the author has followed Wild in Flora Zambesiaca 1, 1:216 (1960) and Elffers *et al.* in Flora of Tropical East Africa (1964) in treating the projecting part of the receptacle as the disc. Strictly speaking, the inner margin or lining of the receptacle should also be regarded as part of the disc.

In the 11 species of *Maerua* in Southern Africa there are six types of disc. These will be discussed in turn and are illustrated in Fig. 1.

1. *Fimbrillate disc*

This type of disc consist of a row of regular fimbrillae not more than 1 mm long. The disc is somewhat fleshy and the fimbrillae are mostly erect, but some are incurved. Actually the disc is very shortly coronate or annular. This disc is present only in *M. brevipetiolata* Killick, a new species from Swaziland described on page 65 of this number of Bothalia.

2. *Four-lobed laciniate disc*

This type consists of dorso-ventrally compressed, unequally laciniate lobes situated opposite the four sepals. The lobes are connected basally. This type of disc is represented in *M. rosmarinioides* (Sond.) Gilg & Ben., *M. juncea* Pax (both subsp. *juncea* and subsp. *crustata* (Wild) Wild and *M. nervosa* (Hochst.) Oliv.

3. *Many-lobed laciniate disc*

The individual lobes of this type are laterally compressed, incurved and laciniate. In side view the lobes resemble cockcombs. Only *M. gilgii* Schinz possesses this type of disc.

4. *Prominently coronate disc*

In this type the disc consists of a prominent corona usually exceeding 2 mm in length with several types of margin. In *M. edulis* (Gilg & Ben.) De Wolf [=*Courbonia glauca* (Klotzsch) Gilg & Ben.] the margin is undulate or denticulate, while in *M. schinzii* Pax and *M. angolensis* DC., it is unequally laciniate.

FIG. 1.—Disc structure in the Southern African species of **Maerua.** 1, **Maerua brevipetiolata**, (*Compton* 30088). 2, **M. rosmarinoides,** (*Tinley* 587). 3, **M. juncea** subsp. **crustata,** (*Theron* 2073). 4, **M. nervosa**, (*Forbes & Obermeyer* 33624). 5, **M. gilgii**, (*Hardy* 596); 5a, single lobe of disc, × 10. 6, **M. edulis**, (*Obermeyer*, *Schweickerdt* & *Verdoorn* 328); 6a, (*Vahrmeijer* 1525). 7, **M. schinzii**, (*Keet* 1534). 8, **M. angolensis**, (*Van der Schijff* 5799). 9. **M. cafra**, (*Louw* 1022). 10, **M. racemulosa**, (*Killick* 118); 10a, (*Borquin* s.n.). 11, **M. parvifolia**, (*Lang* in TRV 31580); 11a, (*Van der Schijff* 87). All × 4, except 5a.

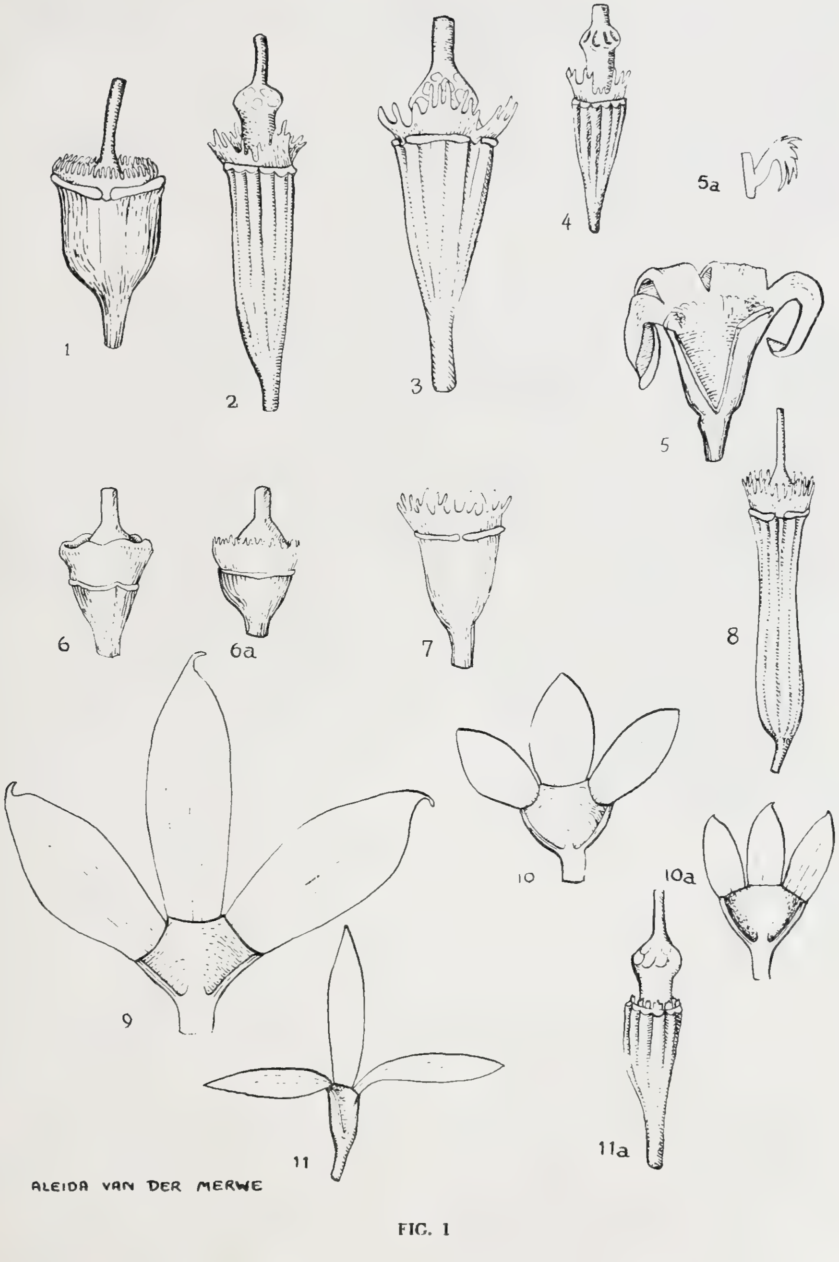

FIG. 1

The main difference between this type of disc and that of (2) above is that the latter is 4-lobed. It is interesting to note that the species with a 4-lobed disc are petaloid, whereas those with a coronate disc are apetalous.

5. *Entire or scalloped disc*

Here the disc is not or scarcely produced beyond the receptacle and the margin is entire or scalloped with the concavities opposite the petal bases. *M. cafra* (DC.) Pax possesses a scalloped disc, *M. racemulosa* (A.DC.) Gilg & Ben. an entire or scalloped disc and *M. parvifolia* Pax an entire or very rarely a minutely denticulate disc.

6. *Denticulate disc*

As mentioned under (5), this disc is sometimes possessed by *M. parvifolia.*

The disc has been used as a character for distinguishing genera, e.g. Pax, and Pax and Hoffmann (*l.c.*), but apparently rarely for distinguishing species. It was found possible, as an academic exercise rather than for practical purposes, to construct a key to the species of *Maerua* using the disc character. However, since some species have the same type of disc, additional floral characters had to be used.

- Disc not produced: entire or scalloped:
  - Sepals less than 6 mm long .... *M. racemulosa*
  - Sepals more than 6 mm long:
    - Sepals 6–11 mm long .... *M. parvifolia*
    - Sepals 12–17 mm long .... *M. cafra*
- Disc produced into corona (or annulus), lobes or minute teeth:
  - Disc coronate (or annular):
    - Disc 0·6–1 mm long .... *M. brevipetiolata*
    - Disc exceeding 1 mm long:
      - Margin of disc undulate or denticulate .... *M. edulis*
      - Margin of disc laciniate:
        - Receptacle infundibular or cylindric, 0·5–1·2 cm long, usually puberulous .... *M. schinzii*
        - Receptacle cylindric, 1·0–1·6 cm long, usually glabrous .... *M. angolensis*
  - Disc lobed or denticulate:
    - Disc lobed:
      - Lobes many, laterally compressed .... *M. gilgii*
      - Lobes 4, dorso-ventrally compressed:
        - Disc less than 1 mm long .... *M. nervosa*
        - Disc 1 mm or more long:
          - Receptacle cylindric .... *M. rosmarinoides*
          - Receptacle infundibular .... *M. juncea*
    - Disc denticulate .... *M. parvifolia*

Bothalia 10, 1: 43–44

A Note on Erythrophleum R. Br. in South Africa

by

J. H. Ross

Abstract

The Natal specimens of *Erythrophleum* have in the past been variously referred either to *E. lasianthum* Corbishley or to *E. suaveolens* (Guill. & Perr.) Brenan (=*E. guineense* G. Don). It was found that all specimens are referable to *E. lasianthum* and that *E. suaveolens* is absent from southern Africa. *E. guineense* G. Don var. *swaziense* Burtt Davy was found to be a synonym of *E. lasianthum*. *E. lasianthum* and *E. africanum* (Benth.) Harms are the only two species encountered in southern Africa. A synopsis of the differences between these two species is given.

Whilst preparing the Caesalpinioideae for the revision of The Flora of Natal and Zululand (Bews, 1921) irregularities in the naming of specimens of *Erythrophleum* became apparent. The Natal specimens, although fairly uniform, have in the past been variously referred to *E. lasianthum* Corbishley or to *E. suaveolens* (Guill. & Perr.) Brenan (=*E. guineense* G. Don). Consequently it was necessary to establish the identity of the Natal specimens.

The stamen filaments in the Natal specimens are woolly tomentose to near the apex and cannot therefore be referred to *E. suaveolens*, which has glabrous stamen filaments. The Natal material is therefore all referable to *E. lasianthum*.

Burtt Davy in Fl. Transv. 2:330 (1932) based his *E. guineense* var. *swaziense* on a specimen collected by *Nicholson* in Swaziland (without a precise locality). This variety differed from typical *E. guineense* " in the much smaller and relatively broader leaflets, which are more obtuse and rounded at base, and less acuminate at apex." Following the placing of *E. guineense* as a synonym of *E. suaveolens* by Brenan in Taxon 9:194 (1960), *E. guineense* var. *swaziense* has been regarded as a synonym *E. suaveolens* [De Winter *et al.* in Sixty Six Transvaal Trees:170 (1966)].

The type of var. *swaziense* is a fruiting specimen. However, four other specimens from Swaziland, all from the Stegi district, have been examined. Of these, one collected by the *Assistant Commissioner* H 30333 (PRE) in Nov. 1924, which is vegetatively indistinguishable from the type of var. *swaziense*, is in flower. The stamen filaments are woolly tomentose to near the apex thus proving the specimen to be referable to *E. lasianthum*. Since no other species of *Erythrophleum* is present in Natal, Swaziland or in southern Mozambique whilst none is present in the Transvaal, it is assumed that Burtt Davy's type specimen is also referable to *E. lasianthum*. There is certainly no distinguishing character to enable any other conclusion to be reached.

Gomes e Sousa in Dendrologia Mozambique 1:244 (1966) records *E. lasianthum* from south of the Limpopo River, but I have seen no specimen from Mozambique. *E. lasianthum*, which is only recorded from Natal (Zululand), Swaziland and southern Mozambique, is apparently geographically isolated from any other species of *Erythrophleum*.

It seems necessary to clarify the various references in literature relating to *E. lasianthum*.

E. lasianthum *Corbishley* in Kew Bull.:27 (1922). Type: Natal, Ingwavuma, Nov. 1919, *District Magistrate* sub PRE H 1228 (K, holo.; PRE).

E. guineense G. Don var. *swaziense* Burtt Davy in Fl. Transv. 2:330 (1932); v. Breitenbach in Indig. Trees of S. Afr. 3:319 (1965). Type: Swaziland, without precise locality or date, *B. Nicholson* s.n. (K, holo.; PRE sub H 30335, iso.). *E. guineense* sensu Henkel in Woody Pl. of Natal and Zululand: 236 (1934). *E. suaveolens* sensu Compton in Annotated Check List of the Flora of Swaziland, J.S. Afr. Bot., Suppl. 6:46 (1966); sensu De Winter *et al.* in Sixty Six Tvl. Trees:170 (1966); sensu Moll in Forest Trees of Natal:69 (1967).

The only other species of *Erythrophleum* encountered in the area delimited for the Flora of Southern Africa is *E. africanum* (Benth.) Harms, which occurs in South West Africa. As in *E. lasianthum*, the stamen filaments in *E. africanum* are woolly tomentose to near the apex although on occasional specimens (not in our area) the filaments are subglabrous. However, *E. africanum* and *E. lasianthum* differ in a number of characters and are readily distinguishable (see Table 1). Furthermore, there is a large geographical discontinuity between the species, *E. lasianthum* having a very restricted distribution in relation to *E. africanum* which is widespread in Africa.

Table 1.—Synopsis of the differences between *Erythrophleum africanum* and *E. lasianthum*

E. africanum	*E. lasianthum*
pinnae 2–5 pairs	pinnae 2–4 pairs
leaflets (6–) 8–17	leaflets 4–13
leaflets narrowly elliptic to elliptic or with ovate tendency, often somewhat asymmetric	leaflets ovate, ovate-elliptic, $\pm$ symmetric
leaflets $1{\cdot}2$–$6 \times 0{\cdot}9$–3 cm in South West Africa	leaflets $1{\cdot}8$–$6{\cdot}5 \times 1$–$3{\cdot}5$ cm
leaflets obtuse or sometimes rounded apically, not acuminate, $\pm$ emarginate	leaflets usually with $\pm$ pronounced acumen apically, emarginate
leaflets usually appressed-pubescent ab- and adaxially, often $\pm$ glabrous above, or glabrous above and below except for pubescence on midrib abaxially	leaflets glabrous, midrib rarely slightly pubescent abaxially
leaflets coriaceous, venation conspicuous ab- and adaxially	leaflets thin, venation relatively inconspicuous apart from midrib
Petiolule pubescent, up to 4 mm long	Petiolule glabrous, up to 7 mm long
Rachides pubescent	Rachides glabrous

The differences between *E. suaveolens* and *E. africanum* were well amplified by Brenan in Fl. Trop. E. Afr. Legum.—Caesalpinioideae 18–21 (1967). As mentioned by Brenan *E. africanum* is " a distinctly variable species ". *E. suaveolens* is readily distinguished from *E. lasianthum* in having glabrous or occasionally subglabrous stamen filaments. Certain vegetative specimens of *E. lasianthum* closely resemble some of those of *E. suaveolens*, but the leaflets in the former are usually smaller. However, because of the geographical discontinuity between the two species, it is unlikely that difficulty will be experienced in naming specimens.

I am grateful to Mr. E. G. H. Oliver, South African liaison botanist at the Royal Botanic Gardens, Kew, England, for information concerning type specimens.

Bothalia 10, 1: 45–54

Stapelieae from South Tropical Africa, V*

by

L. C. Leach

Abstract

The generic position of *Huernia verekeri* Stent and some related species is discussed. *H. verekeri* Stent var. **pauciflora** Leach is described, also several putative hybrids of *H. verekeri*. Three new combinations are made, viz. **H. tanganyikensis** (Bruce & Bally) Leach (*Duvalia tanganyikensis* Bruce & Bally), **H. procumbens** (R. A. Dyer) Leach (*Duvalia procumbens* R. A. Dyer) and **H. andreaeana** (Rauh) Leach (*Duvalia andreaeana* Rauh).

The discovery of a creeping variety of *Huernia verekeri* Stent, which appeared to be very close to *Duvalia* Haworth, led the writer to examine carefully the generic position of the group of related taxa which included *Duvalia tanganyikensis* Bruce & Bally, *D. procumbens* R. A. Dyer, *D. andreaeana* Rauh and *Huernia schneideriana* Berger; the conclusions reached, from the study of a relatively large quantity of material as well as of the published descriptions and figures, are set out below.

Huber in Prodr. Fl. S.W. Afr. 114: 38 (1967) suggests that *H. verekeri* should be considered to be a *Duvalia* rather than a *Huernia* and includes it in his keys to both genera. There seemed, at first sight, no reason why the new variety should not be placed in *Duvalia* and yet the typical variety appeared to be correctly placed in *Huernia* as did also the closely related *H. schneideriana.*

However, although many of the generic distinctions in the *Stapelieae* are somewhat arbitrary, it is considered that, in the two genera concerned, ther are good diagnostic criteria on which they may be satisfactorily separated. An analysis now follows, with the characters arranged in order of relative reliability, the above-mentioned somewhat controversial species being temporarily omitted.

	DUVALIA	HUERNIA
(1)	Corona stipitate with the outer corona resting on the rim or sides of the annulus (i.e. closing what corresponds to the tube in *Huernia*) *No exception known*	Corona sessile with the outer corona, when present, closely appressed to the base of the tube *No exception known*
(2)	Stem teeth with a pair of denticles (stipules) at the base of the leaf *One exception*: *D. sulcata* N. E. Br.	Stem teeth without denticles *No exception known*
(3)	Corolla lobes replicate, at least to some extent (occasionally only slightly folded towards the apex) *Exceptions*: *D. sulcata* with slightly convex lobes and possibly some specimens of *D. polita* var. *parviflora*	Corolla lobes not replicate, usually to some extent channelled or canaliculate towards the apex, sometimes flat or convex *No exception known*

*I–IV published in *J. S. Afr. Bot.*

(4) Corolla lobes usually ciliate, at least to some extent *Exceptions*: *D. elegans*, *D. pubescens* and possibly *D. radiata*	Corolla lobes not ciliate *No exception known*

No. 4 is not particularly useful, as the cilia are frequently lost when specimens are preserved, nevertheless when they are present then *Duvalia* seems definitely to be indicated.

Omitted from the above analyses as not being diagnostic in the present context are:—

Raised annulus:—occurring in both genera
Intermediate lobes:—occurring in both genera to some extent although usually much more prominent in *Huernia*
Corona shape:—the outline of the outer corona and the form of the inner lobes are closely matched in both genera
Pollinia:—do not appear to display any generic morphological correlation

Note:—No trace of denticles was found in any of the *Huernia* species examined, particular attention being paid to species considered to be closely related to, or with stems somewhat similar to those of *D. tanganyikensis* etc.

D. sulcata: despite appearing twice as an exception appears to be correctly placed in *Duvalia* on its remaining morphological criteria, and moreover, fails entirely to qualify for consideration for any other genus.

On the evidence of the foregoing, it is considered that, although closely related, separation of the two genera is not only amply justified, but that they may possibly prove to be the most distinctly differentiated in the whole tribe.

It remains now to consider the position of the taxa excluded from the foregoing analyses.

D. tanganyikensis, *D. procumbens* and *D. andreaeana*: In all three species the coronas are sessile, the stem teeth devoid of denticles and the corolla lobes neither replicate nor ciliate.

From this it appears that the only way in which they approach *Duvalia* is in the shape of the corolla with its raised annulus; at first sight the flowers do have a *Duvalia*-like appearance, particularly those of *D. procumbens*, but this seems to be quite superficial. The shallowness of the tubes contribute to this appearance but cannot be considered to be at all significant, as may be demonstrated by comparison with the almost flat corolla of *H. marnieriana* Lavranos which is undoubtedly correctly generically placed; furthermore the corolla lobes of all three are either channelled or have a tendency to become canaliculate.

It appears, therefore, that these taxa should be transferred to *Huernia* with the diagnostic characters of which they entirely agree, while their stems are also comparable with those of such species as *H. aspera* N.E. Br., *H. erinaceae* Bally and *H. repens* Lavranos.

H. verekeri and *H. schneideriana*: On analysis these both fail to comply with any of the requirements of *Duvalia* as set out above while agreeing in all respects with those of *Huernia*; there seems every reason, therefore, why these should be retained in *Huernia*.

This proposed rearrangement of three species, it should be noted, requires no amendment to the existing generic circumscription of *Huernia*, moreover " corona stipitate " vs. " corona sessile " may be used as a key character for the separation of the genera, alternatively " stem teeth with denticles " vs. " stem teeth without denticles " may serve with almost equal accuracy.

Phytogeographic considerations also lend some support to the presently proposed transfers as, although *Huernia* " blankets " a vast area, *Duvalia* is, with the exception of *D. polita* N. E. Br. and *D. sulcata* N. E. Br. (Arabia), restricted to the southern and south-western portions of Africa. *D. polita* is now known to be distributed from Angola to Mozambique and from Natal to Zambia, its territory including practically the whole of that of *H. verekeri*, so that we have the interesting situation where two species, one from each of these closely related genera, occupy the same area and habitats and yet, despite the hybridising propensities of *H. verekeri* when in contact with other *Huernia* species, not one case of suspected hybridisation with *D. polita* has been reported from this most extensive area.

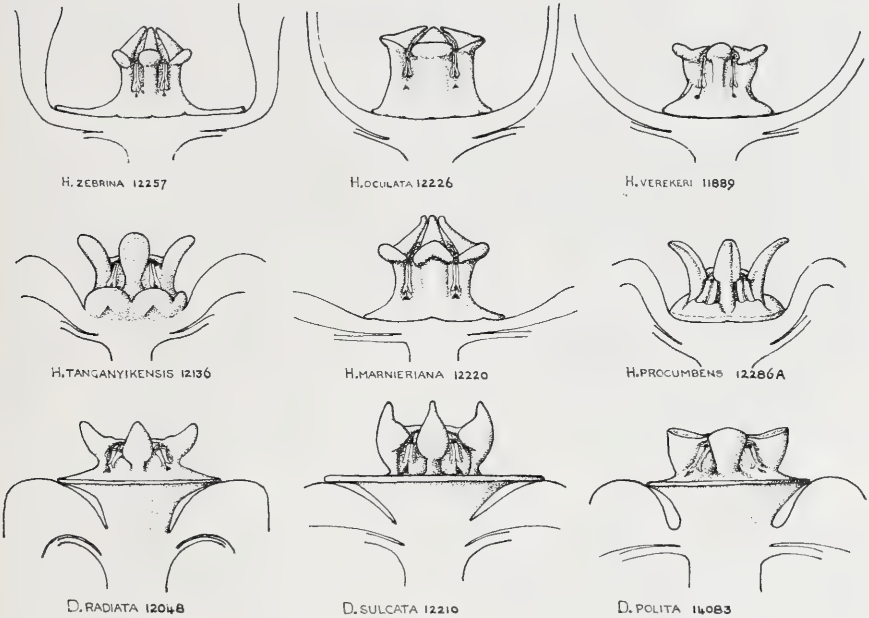

FIG. 1.—A comparison of some characteristic **Huernia** and **Duvalia** coronas with corolla sections. Drawn from specimens in the author's spirit collection, as follows:— 12257 **Huernia zebrina,** Moamba, Mozambique; 12226 **H. oculata,** Usakos, S.W. Africa (*Hardy* s.n.); 11889 **H. verekeri** var. **pauciflora,** Mambone, Mozambique; 12136 **H. tanganyikensis,** Mt. Longido, Tanzania (comm. R.D. *Bayliss*); 12220 **H. marnieriana,** Arabia (*Lavranos*); 12286A **H. procumbens,** Nuanetsi, Rhodesia; 12048 **Duvalia radiata,** Ladismith (*Bayliss* 1912); 12210 **D. sulcata,** Aden (*Lavranos* 1068); 14083 **D. polita** var. **parviflora,** Pietersburg (*Plowes* 2635). All × 4 approx.

On making a study of material and especially of living plants of *Huernia verekeri* Stent, one is immediately struck by the remarkable uniformity of floral characters displayed by this species. Despite its wide distribution only slight variations have been noted, these being restricted to the precise outlines of the corona and the dimensions and depth of colour of the corolla.

In all species of the genus known to the author the variation in the shape of the outer corona is such as to render that organ virtually valueless for diagnostic purposes, at or below specific level. *H. verekeri* is no exception in this respect and the lobed form of

which White & Sloane based their variety *stevensonii* has been found to occur in widely scattered individuals, sometimes as an individual aberrant among flowers with the more usual subcircular corona; it has not been possible, therefore, to uphold this variety.

Size of flowers, at least within this species, seems to be almost, if not entirely, a matter of nourishment, as may be seen from the comparison between wild and cultivated specimens of *Wild & Drummond* 6921.

Generally the species is of very scattered occurrence but, in favourable seasons, large concentrations of plants have been found in the Sabi Valley of Rhodesia, particularly in the vicinity of Birchenough Bridge.

Near the mouth of the Save (Sabi) River in Mozambique a vegetative variant occurs, which, despite its entirely different stems and habit, is considered to be best treated as being only of varietal rank, especially as it seems possible that the one small population found may be of clonal origin.

Huernia verekeri Stent in Kew Bull. 1933:145 (1933); Phillips, Flow. Pl. S. Afr. 15: t. 591 (1935); White & Sloane, Stap. 3:848 (1937); Luckhoff, Stap. S. Afr. 199 (1952); Jacobsen, Handb. Succ. Pl. 2:630 (1960); Huber, in Prodr. Fl. S. W. Afr. 114:38 (1967). Type: Rhodesia, Sabi Valley, *L.S.A. Vereker* 5427 (K. holo.; PRE!).

H. verekeri var. *stevensonii* White & Sloan, l. c. 850, 1145 (1937); Jacobs., l. c. (1960). Type: Rhodesia, Nyamandhlovu District (No specimen appears to have been preserved).

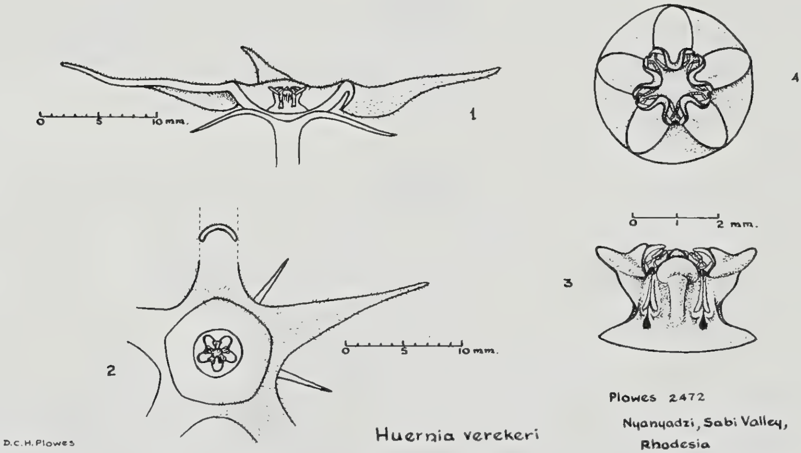

FIG. 2.— **Huernia verekeri** var. **verekeri.** 1, section of corolla with corona; 2, portion of flower from above; 3, corona, side view; 4, corona, from above. All *Plowes* 2472.

The relationship of this species appears to be broadly with the taxa of the *H. macrocarpa* Sprenger affinity, such as *H. oculata* Hook. f. and *H. schneideriana*, while there is also a close relationship between the new variety and *H. procumbens* (the transfer of which from *Duvalia* is effected elsewhere in this paper).

From *H. oculata* and *H. schneideriana* this widespread taxon may immediately be distinguished by its narrowly attenuate corolla lobes and its entirely different coloration; in addition the long, attenuate sepals usually much exceed the corolla sinuses and, together with the attenuate lobes, impart a rather spidery appearance which it shares with *H. procumbens*, and which is quite unlike that of any of its other relatives.

The typical variety is almost certainly nearest in overall characters to *H. schneideriana* which also has similar short acute hairs clothing the limb and lobes. The possibility that this latter species is of hybrid origin is discussed elsewhere in this paper.

Var. *pauciflora* seems to be closest, in many ways, to *H. procumbens* from which it is easily distinguished by its more open, larger tube and lack of a prominent annulus.

var. **verekeri**

Plant succulent, dwarf, caespitose, glabrous, usually very floriferous. *Stems* up to 10 cm high, 1·25 cm diam. excluding the teeth, 5–7, usually 6-angled, sharply sulcate between the strongly toothed angles; teeth spreading, deltoid acuminate, up to 15 mm high, laterally much compressed when young. *Inflorescence* from near the base of the younger stems, flowers opening more or less successively, produced from a stout cuspidate peduncle. *Pedicel* c. 10 mm long, glabrous. *Sepals* 5–8 mm long, narrowly ovate attenuate, usually much exceeding the sinuses of the corolla. *Corolla* c. 3·5 cm diam., outside glabrous, whitish at the base becoming pale green above, usually flushed pink; *tube* more or less hemispherical, c. 3 mm deep, inside whitish at the base becoming suffused with maroon above, deepening to the dark maroon, subcircular or obtusely pentagonal annular rim, 6·5–8 mm diam., sharply dividing the tube from the limb; *limb* and lobes pale greenish yellow, covered with short, stout, acute, maroon hairs; *lobes* horizontally spreading, c. 5 mm wide at the base, 15 mm long, attenuate, markedly convex on the upper surface; *intermediate lobes* small, strongly reflexed, so that they are usually visible only from beneath. *Outer corona* c. 3 mm diam. subcircular or obscurely lobed (rarely distinctly 5-lobed), closely appressed to the base of the tube, glabrous, ivory. *Inner corona* lobes closely incumbent on the anthers, but shorter than them, with a flattened, broadly rounded or somewhat sharply ovate, spreading dorsal gibbosity which tapers sharply into the somewhat obtuse, raggedly pubescent apex, usually slightly suffused with pink. *Pollinia* yellow-brown (appearing dark brown in their cells), attached to the winged, dark brown carrier by translucent red-orange connectives.

Botswana.—Ngamiland, between Nokareng and Aha hills, *Wild & Drummond* 6921 (SRGH), idem cult. SRGH (K; PRE; SRGH), cult. Nelspruit (NBG).

S. W. Africa.—Okavango, Andara, near Caprivi Strip, *Giess* 9576 (HSWA; M).

Zambia.—Feira: near Feira, *Fanshawe* 9424 (SRGH).

Rhodesia.—N. Darwin: Mt. Darwin, *Bingham* s.n. cult. SRGH 3176 (K; LISC; SRGH). Sipolilo: 5 miles west of Kanyemba *Müller & Kerr* 362 (SRGH). Binga: Mwenda Research Station, cult. SRGH, *Grosvenor* 123 (SRGH); ibid. *Mitchell* 910 (SRGH). W. Nyamandhlovu: Tjolotjo Rd., 50 miles north-west of Bulawayo, *Plowes* s.n. (PRE); Rochester Farm, cult. Nelspruit, *Leach & Bullock* 13199 (HSWA; M; NBG; NDO; Z); Farm Burford; *Paterson* in Herb. Bul. Mus. 32 (SRGH). Plumtree: Nata River, *Davies* in SRGH 23215 (SRGH); 6 miles west and 6 miles north-west of Plumtree, *Bullock* 141; 147 (SRGH). Wankie: Deka Rd., *Levy* s.n. (PRE); Lukosi River, *Geise* s.n. (PRE); Wankie, *Paterson* in Herb. Bul. Mus. 50 (SRGH). E. Chipinga: Sabi Valley, *Vereker* in SRGH 5427 (PRE); ibid. *Vereker* s.n. (PRE); *Thorncroft* s.n. in PRE 19574 (PRE); near Birchenough Bridge, *Obermeyer* in TRV 37493 (PRE), ibid. *Leach* 5579 (PRE; SRGH). *Leach* 9972 (SRGH). Melsetter: Hot Springs, *Vereker* in Herb. Eyles 7631 (SRGH); Biriwiri, *Plowes* 2560 (PRE; SRGH); Umvumvumvu River, cult. Nelspruit, *Plowes* sub Leach 12313, (K; SRGH); ± 10 miles north-east of Birchenough Bridge, *Leach & Müller* 13140 (SRGH). Umtali: Maranke Reserve, *Robisnon* in SRGH 41637 (SRGH). S. Bikita: Bikita, *Wild* 4422 (PRE; SRGH); Moodie's Pass, *Leach* 9768 (PRE; SRGH); near Birchenough Bridge, *Stock* in SRGH 20039 (SRGH); ibid. *Hall* 1138 (NBG). Gwanda: Mwewe River, *Bullock* 105 (PRE; SRGH); Gwanda, *Paterson* in Herb. Bul. Mus. 302–307 (G; K; PRE; Z). Ndanga: Gurudzi River, 9 miles north of Chipinda Pools, *Bullock* 134 (SRGH). Nuanetsi: Lundi River, *Taylor* in NBG 563/51 (NBG), ibid. cult. Nelspruit, *Cannell* sub Leach 13799 (K; LISC). Some of the Chipinga District records are not precisely located by the collectors and have been allocated to that district on the score of probability

Malawi.—S. Province, Mpatamanga Gorge, *Leach* 5637; 10591 (SRGH).

Mozambique.—Tete: Mesuza, *Chase* 2820A (SRGH).

var. **pauciflora** Leach, var. nov.

A varietate typica caulibus repentibus multo longioribus, angulis obtusis, dentibus parvissimis distantioribus; floribus paucioribus facile distinguenda.

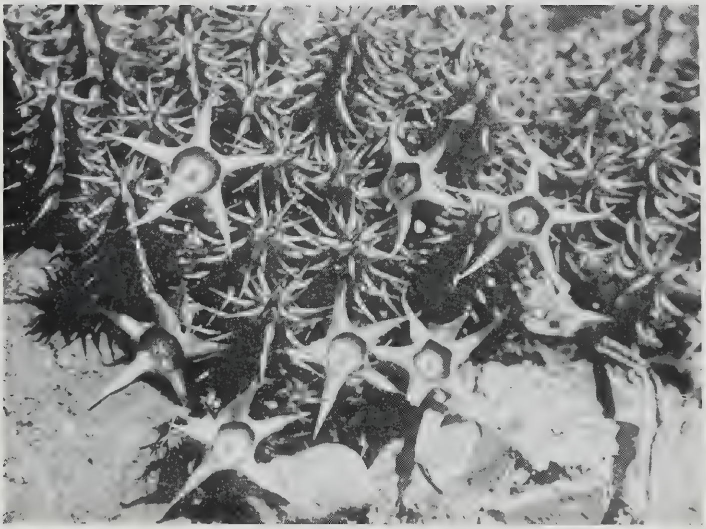

PLATE 1.—**Huernia verekeri.** Plant from Nyamandhlovu District, Rhodesia, showing the variation in the shape of the tube (*Plowes* 1901). Photo: D. C. H. Plowes.

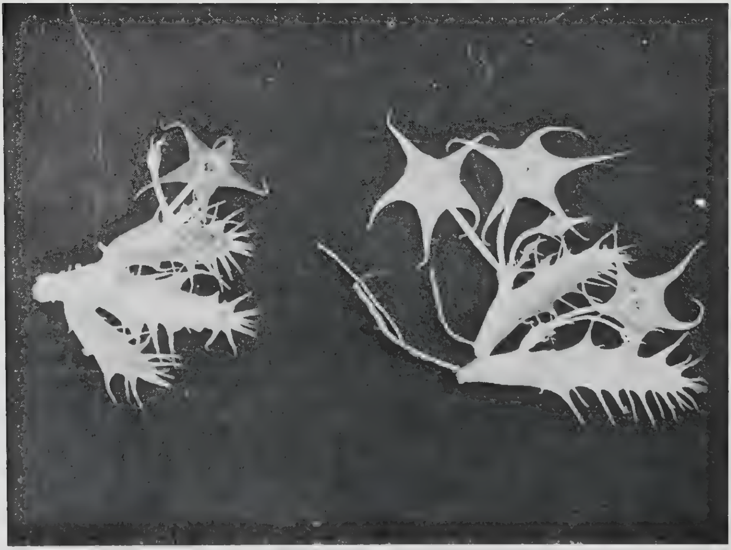

PLATE 2.—**Huernia verekeri.** Comparison of wild and cultivated (right) specimens. Botswana (*Wild & Drummond* 6921).

Type: *L. C. Leach & R. D. Bayliss* 11889 (SRGH, holo.; K; LISC; PRE).

MOZAMBIQUE.—Sul do Save: Save River near Mambone, alt. c. 3 m, cult. Nelspruit, *Leach & Bayliss* 11889 (K; LISC; SRGH), idem cult. PRE (PRE).

Var. *pauciflora* was found growing under heavy shade in a thicket to the south of Mambone, near the mouth of the Save River, on slightly rising ground in an area of mangroves and swampy tidal inlets, and is known only from this locality (similar plants have recently been reported from the lower Sabi Valley, but as no material exists it has not been possible to confirm this report).

It was at first thought that the elongated creeping stems of these plants might be developed only under the heavy shade conditions under which they were discovered but when placed in cultivation at Nelspruit under varying degrees of shade, they have retained their characteristic habit (eventually not thriving unless heavily shaded), as have also those culitvated at both the Botanical Research Institute, Pretoria, and the National Botanic Gardens, Kirstenbosch. Plants of the typical variety have likewise retained their normal floriferous, caespitose habit in cultivation.

Var. *pauciflora* differs from the typical variety in being a sparingly branched, creeping plant with very much longer stems with rounded angles and much smaller more distantly spaced teeth; flowers are borne very much more sparingly towards the base of the younger parts; in these respects the plant is very different from the floriferous, strongly toothed, erect, dwarf clumps of var. *verekeri*.

PLATE 3.—**Huernia verekeri** var. **pauciflora.** Cult. Nelspruit (*Leach & Bayliss* 11889).

It has become apparent that *H. verekeri* tends to hybridize freely with its neighbours and, from a study of such putative hybrids, it appears that the dominant characters of *H. verkeri* are:—

1. Stems with a tendency to a greater number of angles and longer, more acuminate teeth.
2. Tube shallow, more or less hemispherical.
3. Limb and lobes of the corolla clothed with short, acute, maroon hairs.
4. Outer corona tending to be less deeply lobed.
5. Inner corona lobes with an enlarged dorsal gibbosity.
6. Shape of pollinia and particularly of the connectives.

The general form of the inner corona, the papillation and the coloration appear to be mainly inherited from the other parent.

Some field records of putative hybrids follow:—

H. verekeri × *H. hislopii* subsp. *hislopii*

Assumed crosses of this parentage show little variation, so much so, that but for the accident of a similar hybrid occurring spontaneously in the Salisbury garden of an observant collector/gardener (Mr. J. A. Whellan), where only *H. verekeri* and *H. hislopii* were previously cultivated, this particular cross might easily have been published as a distinct species. The accumulated evidence however, leaves little doubt regarding its parentage.

RHODESIA.—Gwanda: near Tuli, cult. Nelspruit, *O. West* sub Leach 11681A (BOL; G; HSWA; K; LISC; M; NBG; NDO; PRE; SRGH; Z). Buhera: Matendera Ruins, cult. Umtali, *Walters* sub Plowes 2636 (SRGH). Umtali: Maranke Reserve, *Plowes* 2577 (PRE; SRGH).

H. verkeri × *H. hislopii* subsp. *robusta*

Very similar to crosses with the typical subsp., but the corona leaning more towards *H. hislopii* and the papillae larger and more dense.

RHODESIA.—Nyamandhlovu: Rochester Farm, *Leach & Bullock* 13200 (SRGH).

H. verekeri × *H. longituba* subsp. *cashelensis*

These assumed hybrids, unlike the foregoing, show considerable variation, as is perhaps to be expected, as *H. longituba* is itself rather variable. Some examples bear a remarkable resemblance in corolla shape to *H. schneideriana*, particularly is this evident in *Leach* 5405 and *Plowes* 2470, both from the same vicinity.

RHODESIA.—Melsetter: Mutambara, *Leach* 5405 (PRE; SRGH); ibid. cult. Nelspruit, *Plowes* 2470 (PRE; SRGH).

Huernia schneideriana Berger in Monatsschr. Kakt., 23: 177 (1913); White & Sloane, l.c. 844 (1937); Jacobsen, l.c. 629 (1960). Type: Tanzania (" Nyassaland "), Rungwe District, Kyimbila (" Kimbila am Nordend des Nyassa-Sees "), *Stolz* 1407 (B†). Neotype: Hort. bot. Monacensis, fl. 31. 10. 1927 (M!).

The type of *H. schneideriana* was a living plant collected by Adolf Stolz at Kyimbila (c. 9°20′S, 33°35′E), which was sent to Berger by the Dahlem gardener Strauss. It seems fairly certain that if herbarium material was prepared by Berger it would have been destroyed during World War II.

Unfortunately only one herbarium specimen seems to have survived. This is preserved at München (M), and is said to have been prepared from the original imported plant and has therefore, been selected as the neotype.

The species is believed to have attained an extensive distribution in cultivation (presumably all clonal divisions of the original gathering) but it is now, apparently, rare in collections.

It has not been possible, in the absence of material, either to confirm or confound the Mozambique localities tentatively mentioned by White & Sloane, (l.c.), but that of Mangulane in the Lourenço Marques District seems particularly doubtful.

Plant tufted, stems c. 5 cm high, 1–1·2 cm diam., generally 6-angled, with relatively small acute teeth about 3 mm high, 16 mm apart along the angles. *Flowers* few, from near the base of the stems, borne on short glabrous pedicels. *Sepals* glabrous, c. 3·5 mm long, 1·25 mm wide. *Corolla* shallowly campanulate, c. 2·5 cm across the points of the lobes; *tube* more or less hemispherical, glabrous, blackish purple inside; *lobes* c. 7 mm long, deltate, acute; both limb and lobes clothed with short, acute, blackish maroon

hairs. *Outer corona* c. 3 mm diam., dark purple, scarcely lobed, slightly undulate on the margin. *Inner corona* with lobes closely incumbent on the anthers but shorter than them with a broadly rounded, more or less flat, spreading dorsal projection.

The above description is based partly on the original description by Berger and partly on the München material.

In view of the fact that *H. schneideriana* has apparently been collected only once and remembering its apparently vigorous qualities, it is thought that the possibility of hybrid origin should be considered. If this possibility is accepted, then consideration of the dominant characters of *H. verekeri* in putative hybrids of that species would suggest it as one of the possible parents, since most, if not all, these dominant characters are possessed by *H. schneideriana*; while its other characters would seem to indicate that the other parent should be sought amongst the dark-flowered species such as *H. aspera* and *H. keniensis*.

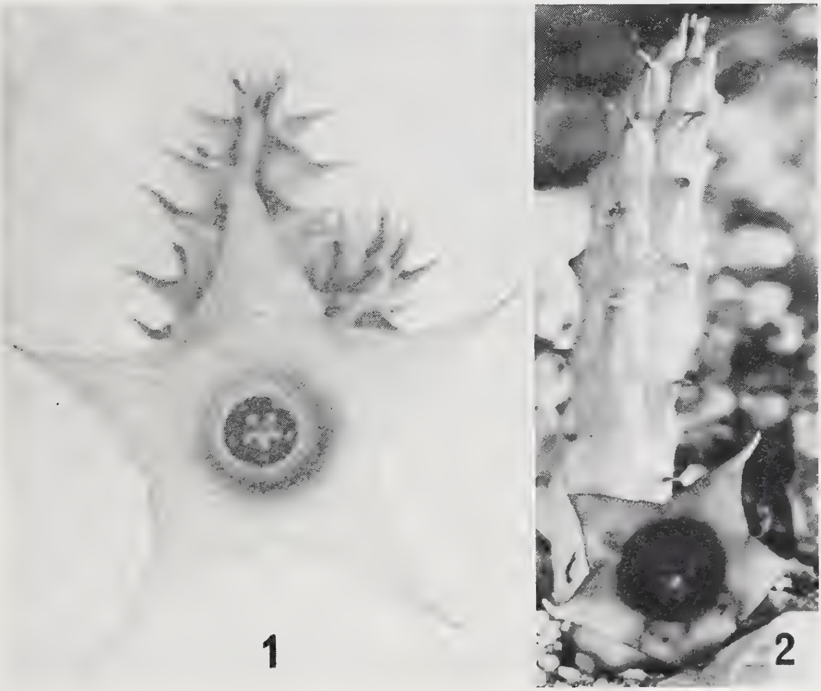

PLATE 4.—1, **Huernia verekeri** × **H. longituba** subsp. **cashelensis.** Melsetter District, Rhodesia (*Leach* 5405); 2, **H. schneideriana.** Cult. " Les Cedres ". Photo: M. J. Marnier-Lapostolle.

What amounts to almost certain confirmation of this hybrid origin theory has recently been received from Professor G. Reese in a paper entitled, " Untersuchungen über die Chromosamenzahlen der Stapelieae " [G. Reese u. H. Kressel, in Port. Act. Biol. Ser. A, 10: 33 (1967)], in which a specimen identified as *H. schneideriana* has been found to be a triploid; in the same article *H. verekeri* is listed as a diploid and a variety of one of the other suggested possible parents is reported as a tetraploid.

The probability of *H. schneideriana* being of hybrid origin is, therefore, of a very high order indeed, while that *H. verekeri* should be one of the parents seems, on the morphological evidence, to be of only a slightly lesser order of probability.

The geographical isolation of *H. schneideriana* from the suggested parents may be more apparent than real, as neither northern Mozambique nor southern Tanzania has been intensively botanised, so that it is quite possible that both may occur, without however having been recorded in herbarium collections.

Huernia tanganyikensis (*Bruce & Bally*) *Leach*, comb. nov.

Duvalia tanganyikensis Bruce & Bally in Cact. & Succ. J. Amer. 13: 179, tt. 114, 115 (1941); Bally in J. E. Afr. Nat. Hist. Soc. 16: 160, t. 53 (1942); Bruce in Flow. Pl. Afr. 28: t. 1082 (1950); Jacobsen, Handb. Succ. Pl. 1: 363 (1960); Rauh in Kakt. u. and. Sukk. 12: 114 (1961). Type: Tanzania, N. Prov., Mt. Longido, *Bally* S. 19.

Tanzania.—N. Prov., Mt. Longido at c. 1,500 m alt. on gneiss, "mat forming cf. *H. aspera*", *Bally* S. 19 (PRE, photos!); ibid. comm. *Bayliss*, cult, NBG 234/59 (PRE); Mbulu: Lake Manyara National Park, 3,500 ft. alt., cult. PRE, fl. 4. iv.1956, *Greenway & Kanuri* 11414 (PRE).

Huernia procumbens (*R. A. Dyer*) *Leach*, comb. nov.

Duvalia procumbens R. A. Dyer in Flow. Pl. Afr. 31: t. 1218 (1956); Rauh, l.c. (1961); Letty, Wild Flowers Transv. 268, t. 133i (1962).

Type: S. Africa, Transvaal, Pafuri, *Van der Schijff* 3618 (PRE!).

Transvaal.—Soutpansberg: 32 miles north of Punda Maria, *Codd* 5389 (PRE); 8 miles west of Pafuri, cult. Nelspruit, *Leach, H. H. & D. C. Mockford* 12277 (G; PRE; SRGH); Kruger National Park, *Van der Schijff* 3618 (PRE).

Rhodesia.—Nuanetsi: PesuRi ver Gorge, ± 12 miles west of Pafuri, cult. Nelspruit, *Leach, H. H. & D. C. Mockford* 12286A (K; LISC; PRE; SRGH; ZSS).

There is considerable variation in the inner corona of this species, the lobes of which may be either widely spreading with the inner face somewhat channelled, or strictly erect and more or less triangular in cross-section; the latter being, apparently, the more common.

Huernia andreaeana (*Rauh*) *Leach*, comb. nov.

Duvalia andreaeana Rauh, l.c. (1961). Type: Tanzania, between Mombasa and Voi, *Rauh* Ke 867 (HEID, holo.; PRE, photos!).

Acknowledgements

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The directors of the following herbaria: Royal Botanic Gardens, Kew (K); Botanische Staatssammlung, München (M); National Botanic Gardens, Kirstenbosch (NBG); Institut für Systematische Botanik der Universität, Zürich (Z), for the loan of material and for information regarding the history of *H. schneideriana*.

M. J. Marnier-Lapostolle for a photograph and a live plant of *H. schneideriana*. Mr. and Mrs. H. Mockford for hospitality when the Pafuri area was visited. Mr. D. C. H. Plowes for the line drawing of *H. verekeri* accompanying this article, for photographs and living plants of that species and of some putative hybrids.

Bothalia 10, 1: 55–82

New and Interesting Records of African Plants

by

Various Authors

AIZOACEAE

A Note on the Identity of Mesembryanthemum brachyphyllum Welw.

In 1873 a paper by Welwitsch on "An undescribed species of *Mesembryanthemum* from the south of Portugal " was published posthumously in J. Bot. 11: 289. In an explanatory note the editor, Trimen, said that Welwitsch had been struck by " some remarkable instances of connection between the vegetation of the southern province of Portugal and the Cape of Good Hope, and had selected this new *Mesembryanthemum* (*M. brachyphyllum*) as the most striking example ". The paper includes a full description in Latin of the species, together with a tab. and reference to type material.

Berger in his Mesembrianthemen und Portulacaceen 292 (1908) included the species in a list of " doubtful and missing species ", while Jacobsen in his Handbook of Succulent Plants 3: 1268 (1960) mentioned that " it is a very ill-defined species ".

Being curious about the identity of this *Mesembryanthemum* growing in Europe, the present author in 1965 wrote to Dr. O. A. Leistner, the Institute's liaison officer at Kew, and asked him to check on the identity of *M. brachyphyllum*. Dr. Leistner replied that the Welwitsch specimen of *M. brachyphyllum* at Kew had been identified by N. E. Brown as *Lampranthus glaucus* (L.) N. E. Br., a Cape species, and that he fully agreed with this determination. It is clear, therefore, that *M. brachyphyllum* must be regarded as a synonym of *L. glaucus*. It is interesting to note that Welwitsch commented that *M. brachyphyllum* was very closely related to *M. glaucum* L. on which *L. glaucus* was based.

It is indeed ironical that the plant from Portugal chosen by Welwitsch to illustrate the similarity between the floras of southern Portugal and the Cape should eventually prove to be a native of the Cape.

The synonymy and literature references can be summarized as follows:—

Lampranthus glaucus (*L.*) *N. E. Br.* in Gard. Chron. 87: 212 (1930); Bolus in Fl. Cape Penins. 385 (1950).

Mesembryanthemum glaucum L., Sp. Pl. 486 (1753); Sond. in Fl. Cape. 2: 417 (1862). *M. brachyphyllum* Welw. in J. Bot. 11: 289, t.136 (1873); Berger, Mesembrianthemen und Portulacaceen 292 (1908); Jacobsen, Handbook of Succulent Plants 3: 1268 (1960).

It should perhaps be mentioned that *M. brachyphyllum* Pax ex Schltr. & Diels taken up in the Index Kewensis is a *nomen nudum* and the species is apparently unrelated to the Welwitsch species. In Schultze's Aus Namaland und Kalahari, p. 693 (1907), Schlechter and Diels mention that a Hermann specimen in Herb. Berlin was annotated by Pax as *M. brachyphyllum* Pax, but that because this name was antedated by *M. brachyphyllum* Welw., they proposed a new name, *M. paxianum*. No description was provided.

R. G. Strey

AMARYLLIDACEAE

A New Species of Crinum

Crinum foetidum *Verdoorn*, sp. nov., foliis latis et humifusis *C. graminicola* Verdoorn atque *C. delagoensi* Verdoorn simile, sed ab ambobus foliis hebetato-turcoisinis non nitidoviridis, perianthii segmentis acuminatis, carneis non rubicundis vel purpureis carinatis, praecipue differt; ab aliis speciebus Africae australis plantis foetidis et seminibus papillosis coloribus sepiaceis differt.

Plantae obtritae foetidae. *Bulbus* globosus, 15–18 cm diam., abrupte in collum brevem vel longum productus. *Folia* 10–16, hebetato-turcoisina, subhumifusa, distincte ciliata; exteriores circiter 70 cm longa, 12 cm lata. *Pedunculus* subpatens, 14–22 cm longus, leviter compressus, $2 \cdot 5 \times 1 \cdot 5$ cm crassus. *Bracteae* involucrates acuminatae, circiter 10 cm longae, base 3 cm latae. *Umbella* circiter 11-flora. *Pedicelli* 0–1·5 cm longi. *Perianthium* infundibuliforme; tubus flavovirescens, circiter 10 cm longus; lobi albidi, carneocarinati, circiter 10 cm longi, acuminati, apiculati, in dimidio superiore, revoluti. *Capsula* subglobosa, rostrata. *Semina* papillosa-rugosa, coloribus sepiaceis. Plate 1.

Type: Transvaal, Waterberg, 70 miles north of Vaalwater, *Louw* 3460 (PRE, holo.).

Most parts of the plant emit a foetid odour when crushed or broken. *Bulb* globose, 15–18 cm diam., abruptly narrowed into a long or short neck; tunics membranous. *Leaves* few, 10 to 16, spreading along the ground, a dull (matt) turquoise-green colour, about 70 cm long, 12 cm broad, margin cartilaginous, obscurely dentate, distinctly ciliate with hairs mostly over 1 mm long. *Inflorescence* with a rather short, 14–22 cm long, peduncle which is subspreading, somewhat compressed, usually $2 \cdot 5 \times 1 \cdot 5$ cm thick. *Spathe-valves* acuminate from a broad base, about 10 cm long, 3 cm broad at the base. *Umbel* about 11-flowered. *Pedicels* 0–1·5 cm long. *Perianth* more or less funnel-shaped; tube green to pale yellowy-green, about 10 cm long; segments white with a delicate pink dorsal band, about 10 cm long, outer about 2 cm broad, inner about 2·5 cm broad, all acuminate and recurved in the upper half, apiculate (apicule often dark rose coloured and up to 1 cm long on the outer segments, shorter on the inner). *Stamens* declinate, filaments white; style red in upper portion. *Capsule* subglobose, with the perianth base persisting like a beak. *Seeds* sepia coloured, rough with raised papillose ridges.

Found in deep coarse sand in the hot, dry western and north-western Transvaal, and northern South West Africa. Probably occurs in the northern Cape, Botswana and Rhodesia, but not yet confirmed.

Transvaal.—Rustenburg: farm Albion near Vaalpenskraal, *Verdoorn* 2495. Waterberg: 70 miles north of Vaalwater, *Louw* 3460 (type); west of Vaalwater near Sterkstroom, *Verdoorn* 2497. Potgietersrus; Steilloop, on Magalakwin, *Verdoorn* 2498.

South West Africa.—Okavango: 8 miles east of Runtu, *De Winter* 3777. Gobabis: *Tölken* 1003.

In November, 1964, Dr. W. J. Louw of Potchefstroom University, brought material of this *Crinum* to the Botanical Research Institute. He had collected it on sandy flats in the north-western Transvaal about 70 miles north of Vaalwater. It was obvious that it did not match any of the known South African species. The material was complete with bulbs, leaves, flowers and fruits represented. Features noted were the broad, matt, bluey-green leaves with rather long ciliae, the distinctly acuminate perianth segments which were predominantly white with a delicate pink keel, and the beaked fruits. Two years later, that is in November, 1966, a search was made for this species in the wild. It was seen in three places in the western and north-western Transvaal. The first group was found about 37 miles west of Thabazimbi in coarse, deep sand

(see Plate 1). Interesting points noticed, in addition to those recorded about Dr. Louw's specimens, were the slightly zygomorphic flowers with revolute segments and the watery leaves which, when torn, emit a foetid odour. Next the species was seen about 9 miles north-west of Vaalwater and lastly at Steilloop on the Magalakwin River. At the last-mentioned site the seeds were seen. They differ from all other South African species in that they are a sepia colour and are rough with raised papillae. The broken or fading capsules had the same unpleasant smell as the leaves have.

Because of the ciliate leaves, the descriptions and types of two tropical species so far unknown in South Africa were investigated, namely *C. harmsii* Bak. and *C. crassicaule* Bak. *C. harmsii* was ruled out after seeing the type specimen and because it is described as having only 3 flowers in an umbel, the leaves only 5 cm broad and Baker puts it in the subgenus Platyaster which means that the flowers are erect and hypocrateriform, whereas ours are trumpet- or funnel-shaped and nodding. The photo on page 348 in Baum's Kunene–Zambesi Expedition (1903) may illustrate *C. harmsii*, the type of which was collected on that expedition, although the illustration is published without a name.

C. crassicaule was described from a specimen which Baines painted and which consisted merely of an inflorescence. In this connection Baines writes in his Explorations in South West Africa, page 188: " Monday 21st (Oct. 1861) . . . I sketched a very beautiful umbel of white and pale purple flowers brought home last night by Chapman, apparently a kind of amaryllis. The main stem (peduncle) was flattened, an inch and a quarter wide and a quarter thick, the bracts had fallen down and whithered . . . . The flower had been too long gathered to restore itself to form when placed in water ". It was solely on this specimen, which was sent to Kew by Baines, that Baker based the species *C. crassicaule* (see Amaryllidaceae, page 85).

Several weeks after painting this inflorescence, while still at Koobis, Baines painted another *Crinum*, on the 13th November (see page 220 of his Explorations). Coloured photographs of the painting done in October as well as the one done in November, were kindly supplied to me by our Liaison Officer at Kew, Mr. E. G. H. Oliver, and, in my opinion, the latter painting represents a species distinct from the one painted in October, but is very definitely conspecific with the species here described, *C. foetidum*.

The October painting of the half-faded inflorescence, the type of *C. crassicaule*, seems to represent a species with erect perianth-tubes and stamens arranged as in the subgenus Stenaster. This interpretarion is supported by the fact that at least two species in the Stenaster or Pachyaster groups occur in the same area.

It would seem from Dr. N. E. Brown's notes, many years later, written on the type specimen of *C. crassicaule* and on the painting done by Baines in November, that he thought they represented the same species. On the type he has written that it was collected at Koobis, Ngamiland, November 13, 1861, whereas it was collected and painted in October, and on the November painting he has written " *Crinum crassicaule* Baker, Handb. Amaryll. p. 83, 1888 ", which it is not. Dr. Brown evidently examined these when he was naming the Lugards' collection of plants from Ngamiland. In the Kew Bulletin 1909, where the list of names is published, N. E. Brown, on page 142, lists Mrs. Lugards' No. 45 as *Crinum crassicaule* and he there describes his concept of the species which, judging from his notes mentioned above, probably includes more than one element. Mrs. Lugards' painting of No. 45 shows an erect perianth-tube and straight, erect filaments suggestive of the Stenaster or Platyaster groups. For this reason it may be *C. crassicaule*, but from her painting the species is not recognizable.

In addition to the November painting by Baines, the photograph published in the Guide to the Victoria Falls by H. Wild, page 135, illustrates a *Crinum*, which is apparently conspecific with *Crinum foetidum*.

I. C. Verdoorn

PLATE 1. **Crinum foetidum.** 1, in flower; 2, in fruit, from Thabazimbi District (*Verdoorn* 2495). Photos: D. Edwards.

CAPPARACEAE

Notes on Boscia

Boscia is an African genus except for one species, *B. arabica* Pest., which occurs in southern Arabia. Most of the species occur in drier parts, but no representatives are found in north-western Africa. *Boscia* is very similar to the genus *Maerua* as also pointed out by De Wolf in Kew Bull. 16: 80 (1962). The flowers of the two genera are very similar, but in *Boscia* petals are usually absent, the receptacle tube is very short and the androgynophore practically non-existent. All these characters are not found in the genus *Capparis* and it is thus surprising that a few South African species of *Boscia* have remained included in *Capparis* for such a long time. Burchell, Trav. 1 (1822) described them and Sonder in Fl. Cap. 1: 60 (1860) did not recognize how different these species were from the rest of *Capparis* and, instead, placed a few species of *Maerua* with apetalous flowers in the genus *Boscia*. At the time the latter genus was not well defined, but soon afterwards Oliver, Fl. Trop. Afr. 1: 92 (1868), gave the genus full recognition and a few South African species such as *B. foetida* Schinz were correctly identified and described in the genus *Boscia*. Pestalozzi in Bull. Herb. Boiss. 6, Appl. 3: 1–152 (1898) undertook the first general investigation of the genus, particularly its anatomy. His study was, however, greatly limited by the small amoun- of material used. Gilg & Benedict in Bot. Jahrb. (1915) revised all the African Capt paraceae. They transferred *Capparis albitrunca* Burch. to the genus *Boscia*, but not the very similar species *C. oleoides* Burch. ex DC. merely because of the presence of petals. With recent revisions of the tropical species available, viz. Hutchinson & Dalziel, Fl. Trop. West Afr. 1: 89 (1927); Wild in Fl. Zamb. 1: 229–35 (1960) and Elffers *et al.* in Fl. Trop. East Afr. (Capparidaceae) 50–58 (1964), and with the wide range of South African material at my disposal, I was prompted to make the following innovations for my treatment of the genus in the Flora of Southern Africa, Vol. 13.

B. oleoides (*Burch. ex DC.*) *Toelken*, comb. nov.

Capparis oleoides Burch. ex DC., Prodr. 1: 248 (1824); Sond. in Fl. Cap. 1: 62 (1860). Type: Cape, Bushmans River, near Rautenbach's Drift, *Burchell* 4200 (K, holo.; PRE!). *C. coriacea* Burch. ex DC., Prodr. 1: 248 (1824). Type: Cape mountains on the south-west side of Graaff-Reinet, *Burchell* 2898 (K, holo.!). *C. clutiaefolia* Burch. ex DC., Prodr. 1: 248 (1824); Sond. in Fl. Cap. 1: 62 (1860). Type: Cape, near Blaauwkrans, *Burchell* 3881 (K, holo.!).

This species is incorrectly placed in the genus *Capparis*, because of the presence of a receptacle tube, valvate sepals and sclereids in the mesophyll. A receptacle tube with a corona on which the petals are inserted and valvate sepals are also found in the genus *Maerua*, but the sclereids in the mesophyll of *B. oleoides* are typical of those found in the genus *Boscia*. No sclereids have been found in the leaves of several species of *Maerua* investigated. In fact, *B. oleoides* is so similar to *B. albitrunca* that the two species have often been confused. However, *B. oleoides* can be distinguished from the latter by its ridged branches with alternate leaves, usually terminal inflorescence and the presence of petals. It occurs in dry vegetation in the eastern Cape as far inland as Graaff-Reinet and the nearest locality of *B. albitrunca* to this is near Hope Town or Victoria West.

B. tomentosa *Toelken*, sp. nov. ab speciebus omnibus Bosciae in Africa australi tomento stellato-piloso differt.

B. polyantha sensu Suesseng., Heine & Roessler in Prodr. Fl. S.W. Afr. 47: 4 (1966).

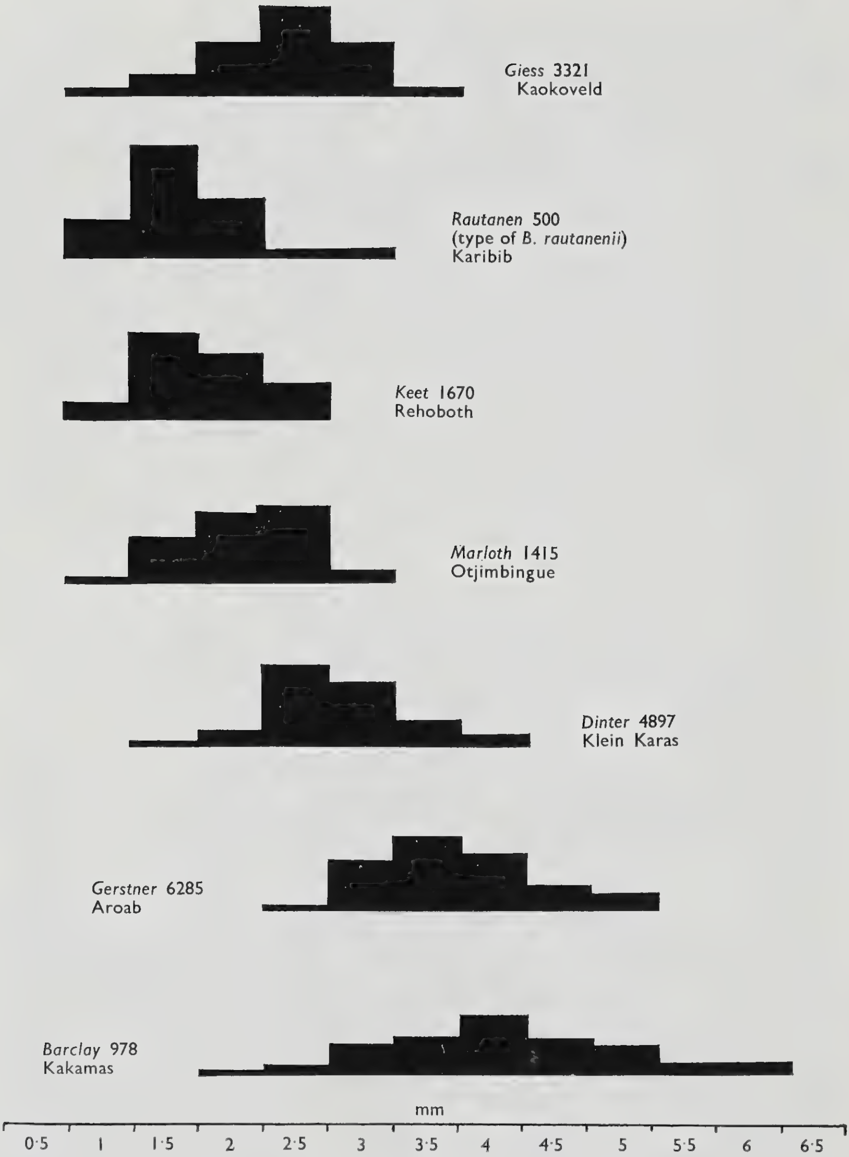

FIG. 1.—Histograms showing the variation of the width of the leaves in **B. foetida** subsp. **foetida.** Fifty leaves of each specimen were measured accurately to 0·5 mm. The specimens were arranged to illustrate the increase in the width of the leaves as the subspecies radiates out towards the north, east and south of the area of distribution of the narrow-leaved form.

Arbusculae rare arbores ad 5 m altae. *Rami* tomentosi, glabrescentes, fere albi. *Folia* non fasciculata; lamina late ovata vel elliptica, obtusa ad emarginatam in apicem, mucronulata, in basem breve angustata vel truncatas 2–4 (–5·5) cm longa, (1–) 1·5–2·5 cm lata, rigide succulenta, tomentosa praecipue stellatopilosa; petiolus (0·4–) 0·6–1 cm longus, tomentosus. *Inflorescentia* terminalis, paniculata; pedunculus 2–5 cm longus, tomentosus; pedicellus 0·3–0·6 cm longus, tomentosus. *Bractea* setacea, 2–4 mm longa, tomentosa. *Sepala* ovata ad oblonga, 2–3 mm longa, extus tomentosa, intra glabra. *Corona* crassa, succulenta, annularis, denticulata. *Stamina* (5) 6–8; filamentum 3–4 mm longum, glabrum. *Gynophorum* 2–4 mm longum, glabrum. *Ovarium* ovoideum, ovulis 12; stigma capitatum, sessile vel paene sessile. *Fructus* non visus.

Type: S.W. Africa, Kaokoveld, Otjinunga, *De Winter & Leistner* 5749 (PRE, holo.).

Shrubs or rarely trees up to 5 m high. *Branches* tomentose becoming glabrous, almost white. *Leaves* alternate not fascicled; lamina broadly ovate or elliptic, obtuse to emarginate at the apex, mucronulate, shortly tapering or truncate at the base, 2–4 (–5·5) cm long, (1–) 1·5–2·5 cm broad, stiff fleshy, tomentose with mainly stellate hairs; petiole (0·4–) 0·6–1 cm long, tomentose. *Sclereids* in the mesophyll without foot, not branched, hardly reaching the centre of the leaf, in clusters, similar on both sides of the leaf. *Inflorescence* terminal, paniculate; peduncle 2–5 cm long, tomentose; pedicel 0·3–0·6 cm long, tomentose. *Bracts* setaceous, 2–4 mm long, tomentose. *Sepals* obovate to oblong, 2–3 cm long, tomentose outside, glabrous within. *Corona* a thick ring, denticulate. *Stamens* (5–) 6–8; filaments 3–4 mm long, glabrous. *Gynophore* 2–4 mm long, glabrous. *Ovary* ovoid, with 12 ovules; stigma capitate, sessile or nearly so. *Fruit* unknown.

In dry bushveld on the north-western border of South West Africa and also in Angola.

South West Africa.—Kaokoveld: near Otjinunga, *De Winter & Leistner* 5749; 5785.

Süssenguth, Heine & Roessler (1966) interpreted the species as *B. polyantha* Gilg but, on investigating the type specimen, *Antunes* A100 (B), it was found that its branches and leaves are pubscent with unicellular hairs, the flowers are densely clustered in an axillary inflorescence, the flowers are not fleshy and the sepals are lanceate-elliptic. In all these characters it differs from *B. tomentosa.* This latter species does not seem to have any direct affinity with any South African species of *Boscia.* The stellate hairs are multicellular and are formed by the fusion of the lower part of several adjoining unicellular, epidermal hairs.

B. foetida *Schinz* in Verh. Bot. Ver. Prov. Brandenb. 29: 49 (1886). Type: S.W. Africa, Keetmanshoop, *Schinz* 326 (Z, holo.!).

This complex species is distinguished from other species, except *B. microphylla*, by its tomentose fruits and the sclereids in the mesophyll of the leaf with a well developed foot. *B. microphylla*, which is obviously very closely related but kept as a separate species at the moment, may have to be incorporated in this complex when a wider range of material becomes available, particularly as it appears from the present study that the *B. foetida* complex is split into a number of geographically separated taxa. Four subspecies can be recognized mainly on the number of stamens.

Trees or shrubs always branching from the base; pedicels with spreading hairs:
  Shrubs or trees with main branches ascending, up to 3 m high; peduncle 0·3–1·5 cm long; stamens 11–15 .... (a) subsp. *foetida*
  Shrublets decumbent, not higher than 30 cm; peduncle absent; stamens 11–12 (–14) (b) subsp. *minima*
Trees with one trunk at least 1 m high; pedicels glabrous:
  Stamens 11–15; pedicels 1–2 cm long .... (c) subsp. *longipedicellata*
  Stamens 5–7 (8); pedicels 0·5–0·8 cm long .... (d) subsp. *rehmanniana*

(a) subsp. **foetida**

B. foetida Schinz in Verh. Bot. Ver. Prov. Brandenb. 29: 49 (1886); Pest. in Bull. Herb. Boiss. 6, Appl. 3: 136, t.2, fig. 1 (1898); Süsseng., Heine & Roessler in Prodr. Fl. S.W. Afr. 47: 3 (1966). *B. rautanenii* Schinz in Viert. Naturf. Ges. Zürich 51: 193 (1906); Süsseng., Heine & Roessler in Prodr. Fl. S.W. Afr. 47: 4 (1966). Type: S.W. Africa, Karibib, *Rautanen* 500 (Z, holo.!). *B. kalachariensis* sensu Dinter in Fedde Rep. 15: 352 (1918).

This subspecies is usually found in rocky outcrops in the dry southern and north-western South West Africa and the adjoining northern Cape Province.

B. rautanenii is only a narrow-leafed form of subsp. *foetida*, occurring in the districts of Swakopmund and Karibib. The histogram (see Fig. 1) illustrates the gradual increase in width of the leaves as the subspecies radiates out towards the north, east and south of the area of distribution of this form.

(b) subsp. **minima** *Toelken*, subsp. nov.

Haec subspecies ab aliis habitibus fruticulis ad 30 cm alta ramis decumbentibus; ab subsp. *foetida* absentia pedunculi et sclerenchymate dissimili; ab subsp. *longipedicellata* pedicello breviore, piloso; ab subsp. *rehmanniana* pedicello piloso et numero staminum differt.

Type: Transvaal, Warmbad, near Makapanstad, *Codd* 8013 (PRE, holo.).

Shrublet not higher than 30 cm, cushion-like with decumbent branches. *Leaves* with lamina oblanceate to elliptic, 0·5–1·3 cm long, 0·2–0·4 cm broad, isobilateral. *Sclereids* in the mesophyll pointed, not branched at the apex, only well developed on the adaxial side. *Inflorescence* racemose, usually fascicled with 2–5 flowers; peduncle absent; pedicel 0·3–0·6 cm long, hairy. *Stamens* 11–12 (–14).

Found on limestone outcrops often near pans, or on clay soils near rivers in the north-eastern Cape, western Transvaal and eastern Botswana.

CAPE.—Mafeking: 50 miles west of Mafeking, *Acocks* 18772; near Mosita, *Brueckner* 529; 14 miles east of Sedilamolamo, *Leistner* 565.

TRANSVAAL.—Thabazimbi: 2–3 miles west of Makoppa, *Theron & Marsh* 253. Warmbad: near Makapanstad, *Codd* 8013.

This subspecies is very similar to subsp. *foetida*. However, it usually grows in areas that are temporarily swamped and even when it is found outside such marshy habitats it does not change its decumbent habit. Although this subspecies shows a slight overlap with the subsp. *rehmanniana*, the two were never found in the same area and appear to be ecologically separated.

(c) subsp. **longipedicellata** (*Gilg*) *Toelken*, comb. nov.

B. longipedicellata Gilg in Notizbl. Bot. Gart. Mus. Berl. 14: 188 (1940). Type: Natal, Weenen, *Peniston* in PRE 24195 (PRE, iso.!).

This subspecies occurs in dry bushveld in central Natal. It has often been confused with *B. albitrunca*, but can be distinguished by its hairy fruits and discolorous leaves. The leaves of subsp. *rehmanniana* in the Lebombo Mountains in northern Natal and Swaziland often attain similar sizes, but no intermediate stamen number has yet been recorded.

(d) subsp. **rehmanniana** (*Pest.*) *Toelken*, comb. nov.

B. rehmanniana Pest. in Bull. Herb. Boiss. 6, Appl. 3: 95 (1898); Burtt Davy, Fl. Transv. 1: 123 (1926); Wild in Fl. Zamb. 1: 235 (1960). Type: Transvaal, Klippan, *Rehmann* 5134 (Z, lecto.!). *B. microphylla* Oliv., Fl. Trop. Afr. 1: 93 (1868), partly,

as to specimen *Baines & Chapman*. *B. kalachariensis* Pest. in Bull. Herb. Boiss. 6, Appl. 3: 98 (1898). Type: Botswana, Lake Ngami, *Fleck* 247 (Z, holo.!). *B. filipes* Gilg in Bot. Jahrb. 33: 221 (1903); Wild in Fl. Zamb. 1: 234 (1960). Type: Mozambique, Lourenco Marques, *Schlechter* 11707 (B, holo.!; BOL!; NH!; PRE!). *B. seineri* Gilg & Engl. in Engl., Pflanzenw. Afr. 3, 1: 242, fig. 158D–F (1915), nomen nudum.

Capparis albitrunca var. *parvifolia* Sim, For. Fl. Port. E. Afr. 2, t.3, fig. 4 (1909). Type: Mozambique, Lourenço Marques, *Sim* 5157 (PRE, holo.!).

This subspecies is found in the dry bushveld of the central and northern Transvaal, Swaziland and north-eastern Natal, extending its distribution into Mozambique, Rhodesia and northern Botswana. The subsp. *rehmanniana* differs from all the other subspecies by its fewer stamens. In the Transvaal a pattern of variation, probably not entirely due to a difference in rainfall, can be observed from the east to the west, varying from big leaves, 1–3 in a fascicle and with no or few sclereids to much smaller leaves, often more than five per fascicle and numerous sclereids. Similarly, in the east the gynophore is hairy becoming gradually glabrous towards the west. Consequently *B. filipes*, as distinguished by Wild (1960), cannot be upheld.

B. microphylla *Oliv.*, Fl. Trop. Afr. 1: 93 (1868), partly, excl. specimen *Baines & Chapman*; Exell & Mendonca, Consp. Fl. Ang. 1: 65 (1937); Süsseng., Heine & Roessler in Prodr. Fl. S.W. Afr. 47: 3 (1966); emended. Type: Bumbo, *Welwitsch* 983 (K, lecto.!).

The species is based on two specimens: *Welwitsch* 983 and *Baines & Chapman* s.n., which are now considered to belong to two different species. The latter specimen has been identified as belonging to *B. foetida* subsp. *rehmanniana*. So, in order to retain the species name in its generally accepted sense, *Welwitsch* 983 was chosen as the lectotype and the description slightly emended to exclude the *Baines & Chapman* specimen.

H. R. Tölken

Notes on Capparis

Recent revisions such as those of De Wolf in Fl. Trop. E. Afr. (Capparidaceae) 58 (1964) and Jacobs in Blumea 12: 385 (1965) have contributed much to a clearer delimitation of the genus *Capparis*. Typical characters such as the stipulate spines, the convex receptacle, imbricate sepals and often the presence of more than two carpels have been particularly emphasized.

In Africa comparatively few species of *Capparis* occur, but most of them are widely distributed. A re-evaluation of the many taxa described from Southern Africa, in the light of the revisions mentioned, has necessitated the following name changes:—

C. sepiaria *L.*, Syst Nat. ed. 10: 1071 (1759); De Wolf in Fl. Trop. E. Afr. (Capparidaceae) 63 (1964). Type: two specimens in LINN, viz. 664·4, " Ind. hab. ad sepes " *Anonymous*; 664·5, India, Madras, Sandras, *Koenig*.

var. **citrifolia** (*Lam.*) *Toelken*, comb. nov.

C. citrifolia Lam., Encycl. Bot. 1: 606 (1785); Eckl. & Zeyh., Enum. 14 (1835); Sond. in Fl. Cap. 1: 62 (1860); Wild in Fl. Zamb. 1: 237 (1960). Type: Cape, without precise locality, in Herb. Lamarck (P, holo.; PRE, photo.!). ——var. *longifolia* Hochst. in Flora 27: 290 (1844). Type: Cape, Uitenhage, Winterhoek, *Krauss* s.n. (TUB, holo.!). ——var. *sylvatica* Eckl. & Zeyh. ex Sond. in Fl. Cap. 1: 612 (1860); Eckl. & Zeyh., Enum. 14 (1835), nomen nudum. Syntypes: Cape, Uitenhage, *Ecklon*

& Zeyher (BOL!; PRE!; SAM!); *Drege* (PRE!); *Krauss*; Gamtoos River, *Thunberg* (UPS; PRE, photo.!). *C. capensis* Thunb., Prodr. 92 (1800); Fl. Cap. 430 (1823). Type: Cape, Gamtoos River, *Thunberg* (UPS, holo.; PRE, photo.!). *C. volkameriae* DC., Prodr. 1: 247 (1824); Gilg & Ben. in Bot. Jahrb. 53: 199 (1915). Type: based on *Volkameria capensis* Burm.f. *C. laurifolia* Gilg & Ben. in Bot. Jahrb. 53: 193 (1915). Syntypes: Cape, Kaimansgat, *Mund & Maire* s.n. (B; PRE, photo.!); Cape, *Drege* 7595 (B!); Knysna, *Pappe* s.n. (B!; SAM!). *C. woodii* Gilg & Ben. in Bot. Jahrb. 53: 194 (1915). Type: Natal, Durban, *Wood* 546 (B, holo.; BOL!; SAM!).

C. sepiaria is a very widespread species being recorded from northern Australia, East Indies, Malaysia, India and most parts of Africa particularly the eastern areas. De Wolf (1964) recognizes three varieties in tropical east Africa, but this does not include the typical variety which is said to be very similar to the var. *subglabra*. Var. *subglabra* also occurs in the northern Transvaal. The second South African taxon, var. *citrifolia*, which occurs mainly in Natal and the eastern Cape Province, is not so similar to var. *subglabra* as De Wolf infers, but is rather like var. *stuhlmannii* (Gilg) De Wolf in its stouter appearance and coriaceous leaves. Var. *citrifolia* differs from var. *stuhlmannii* in that it produces spreading hairs (rarely absent), the margins of the sepals are ciliate and there are up to 15 ovules per ovary. In itself var. *citrifolia* is very variable and extreme forms are very different. In forests usually west of Port Alfred the plants are glabrous, often without spines on the branches and produce long lanceate leaves up to 8 cm long. In dry bushveld, on the other hand, densely pubescent plants with leaves rarely longer than 4 cm and well-developed spines are found. Although even the flowering times are often different, intermediate forms between all these characters have been observed. From Estcourt a form is recorded with unusually long and narrow leaves rather resembling the coppice growth of var. *citrifolia* in the eastern Cape.

Volkameria capensis Burm.f. might be the oldest name for this taxon, but under present circumstances it is regarded as a *nomen dubium*. The diagnosis does not give any clue as to the identity of the plant and the type specimen cannot be found. However, the description of *C. volkameriae* DC. which is based on Burman's species, mentions recurved stipulate spines, ovate leaves and c.30 stamens. This obviously refers to var. *citrifolia*, but contradicts Burman's diagnosis which states that the plant is without spines. In var. *citrifolia* spineless specimens have often been observed particularly in the western part of the variety's distribution, a part which had probably been explored before the time of Burman's description. However, the difference of such a conspicuous character indicates that the two authors must have been working on different specimens. Consequently, it is considered that the identity of *Volkameria capensis* Burm.f. cannot be evaluated unless the type specimen can be traced. *C. capensis* Thunb., though possessing the same specific epithet as *V. capensis*, does not refer to Burman's species. This was pointed out by Dandy in Bothalia 7: 427–8 (1961).

C. fascicularis *DC.*, Prodr. 1: 248 (1824); De Wolf in Fl. Trop. E. Afr. (Capparidaceae) 65 (1964). Type: Ghana, *Brass* (BM, holo.; PRE, photo.!).

Two varieties are recognized in South Africa and can be distinguished as follows:—

Leaves oblong, oblong-elliptic to elliptic-lanceate, usually emarginate; inflorescence with 1–3 flowers in the axils of the leaves towards the end of branches, rarely on short lateral branches .... (a) var. *fascicularis*

Leaves lanceate, acuminate; inflorescence axillary racemose .... (b) var. *zeyheri*

(a) var. **fascicularis.** De Wolf in Fl. Trop. E. Afr. (Capparidaceae) 65 (1964).

C. transvaalensis Schinz in Vjschr. Naturf. Ges. Zürich 57: 556 (1912); Marais in Bothalia 8: 165 (1964). Type: Transvaal, Mahilaskop, *Schlechter* 4510 (Z, holo.; BOL!). ——var. *calvescens* (Gilg & Ben.) Marais in Bothalia 8: 165 (1964). *C. schlechteri* Schinz, l.c. 555 (1912). Type: Cape, Tsitsa River, *Schlechter* 6385 (Z,

holo.!). *C. calvescens* Gilg & Ben. in Bot. Jahrb. 53: 195 (1915). Type: Natal, Tugela, *Wood* 8472 (B, holo.; NH!). *C. rudatisii* Gilg & Ben., l.c. 198 (1915); Wild in Fl. Zamb. 1: 239 (1960). Syntypes: Natal, Port Shepstone, Friedenau, *Rudatis* 1388 (B, holo.; PRE!); Weenen, *Wood* 4438 (B, holo.; BOL!; NH!). *C. solanoides* Gilg & Ben., l.c. 197 (1915). Type: Natal, Little Noodsberg, *Wood* s.n. (B, holo.; SAM!). *C. flanaganii* Gilg & Ben., l.c. 197 (1915). Type: Cape, Komga, *Flanagan* 809 (B, holo.; BOL!; GRA!; PRE!; SAM!). *C. marlothii* Gilg & Ben., l.c. 198 (1915). Type: Cape, Hermanus?, *Marloth* 2599 (B, holo.!; PRE!).

(b) var. **zeyheri** (*Turcz.*) *Toelken*, comb. nov.

C. zeyheri Turcz. in Bull. Soc. Natur. Mosc. 27: 324 (1854); Sond. in Fl. Cap. 1: 63 (1860); Gilg & Ben. in Bot. Jahrb. 53: 197 (1915). Type: Cape, Krakakama Forests, *Zeyher* (BOL!; PRE!). *C. volkameriae* sensu Eckl. & Zeyh., Enum. 14 (1835).

This species which is widespread in Africa can be recognized by its characteristic leaves and sessile inflorescence, i.e. several flowers in the axil of a leaf. In the leaf, the first and second pair of secondary veins are usually much longer and more pronounced and join the primary vein at a very acute angle. The flowers are slightly zygomorphic with the anterior sepal usually slightly saccate and the adjoining petals are usually broader with a pronounced villose base.

In South Africa the species occurs in a wide range of habitats and shows an interesting series of variation with distribution. A complete range of 8–23 stamens is found in a decreasing series from north to south. Thus the South African form could not be ascribed to either var. *elaegnoides* or var. *fascicularis* as intepreted by De Wolf (1964). Similarly, in northern Swaziland and around Barberton, 14–18 stamens are often produced and thus the critical difference between var. *transvaalensis* and var. *calvescens* as distinguished by Marais (1964) falls away. In central Natal the number of stamens is about ten decreasing gradually to eight in the vicinity of King William's Town. Concomitant with the change of stamen number, is a gradual decrease in flower size, which is particularly noticeable in the size of the sepals. Specimens from the vicinity of Bathurst and King William's Town show a marked tendency for the flowers to be borne on short lateral branches with usually one or two flowers at the node, but very often without a leaf subtending this axillary, sessile inflorescence. in var. *zeyheri* a delicate axillary " raceme " is found. However, occasionally two flowers per node are produced indicating that the inflorescence is a raceme-like panicle. Actual intermediates between var. *zeyheri* and var. *fascicularis* have not been seen, but their close contact in the area around King William's Town and Bathurst suggests that not even subspecific rank can be applied. Var. *zeyheri* differs from var. *fascicularis* in its lanceate, acuminate leaves. Also, var. *zeyheri* occurs usually in coastal forests, whereas var. *fascicularis* is found in inland forests or bushveld.

Var. *zeyheri* extends its distribution slightly more west than var. *fascicularis* and is found just west of Port Elizabeth. Var. *fascicularis*, however, has never been recorded west of this and the inscription on the holotype of *C. marlothii* (a synonym) in Marloth's hand as being collected at Hermanus must be an error; the isotype in PRE was collected near King Willim's Town, which seems highly feasible judging by the characteristic inflorescence exhibited by both these specimens.

H. R. Tölken

A New Species of Maerua

Maerua brevipetiolata *Killick* sp. nov., *M. rosmarinoidei* (Sond.) Gilg & Ben. affinis, sed plantis constanter semiscandentibus, foliis secundis, foliolis brevioribus latioribusque, petiolis multo brevioribus, receptaculo campanulato, petalis edactis, disco annulari fimbrillato non lobato inaequaliter laciniato differt.

Plantae semiscandentes, ad 3 m altae. *Folia* (1) 3-foliolata, breviter petiolata, glabra; lamina linearis vel anguste elliptica, 1·2–3·2 cm longa, 2–4 mm lata, foliolo mediano lateralibus longiore, apice obtuso mucronulato, basi cuneata, margini nonnihil revoluto, costa supra depressa subtus prominenti; petiolus 0·5–7 mm longus; petiolulus 1–1·5 mm longus. *Inflorescentia* floribus terminalibus paucis racemosa; pedicelli 4–10 mm longi. *Receptaculum* campanulatum, 4 mm longum, 4 mm latum; discus annularis, fimbrillatus, semicarnosus, 0·6–1 mm longus. *Sepali* nonnihil naviculares, late ovati, 7 mm longi, 5 mm lati, apice leviter uncinato, margine nonnihil revoluto ciliolato. *Petala* redacta, ovata, 1·4 mm longa, 0·5 mm lata, unguiculata. *Androphorum* 3 mm longum. *Stamina* c. 30, candida (teste *Compton* 30088); filamenta 1·2 cm longa; antherae oblongae, 1·3 mm longae basifixae. *Gynophorum* 1·4 cm longum; ovarium oblongum, 2 mm longum, stigmate capitato. *Fructus* ellipsoideo-cylindricus, 1·8–2·5 cm longus, 0·9–1·1 cm diam., colliculatus. *Semina* subglobosa, c. 3 mm diam. FIG. 2.

Type: Natal, Ingwavuma Poort, c. 500 feet, 18 July, 1960, *Compton* 30088 (PRE, holo.).

Scrambler up to 3 m high. *Leaves* (1) 3-foliolate, shortly petiolate, glabrous; leaflets linear or narrowly elliptic, 1·2–3·2 cm long, 2–4 mm wide, the middle leaflet longer than the laterals, apex obtuse, mucronulate, base cuneate, margin somewhat revolute, midrib depressed above, prominent below; petiole 0·5–7 mm long; petiolule 1–1·5 mm long. *Inflorescence* of few-flowered terminal racemes; pedicels 4–10 mm long. *Receptacle* campanulate, 4 mm long, 4 mm wide at mouth; disc annular, fimbrillate, with erect and some incurved fimbrillae, semi-carnose, 0·6 mm long. *Sepals* broadly ovate, somewhat boat-shaped, 7 mm long, 5 mm wide, apex slightly uncinate, margin somewhat revolute, ciliolate. *Petals* reduced, ovate, 1·4 mm long, 0·5 mm wide, clawed. *Androphore* 3 mm long. *Stamens* about 30, white (teste *Compton* 30088); filaments 1·2 cm long; anthers oblong; stigma capitate. *Fruit* ellipsoid-cylindric, 1·8–2·5 cm long, 0·9–1·1 cm diam., colliculate. *Seeds* subglobose, c. 3 mm diam.

This species was first collected in 1956 by Murdoch near Big Bend in Swaziland. Several years later it was collected by Professor R. H. Compton at Ingwavuma Poort in Northern Zululand (not in Swaziland as indicated on the label of *Compton* 30088). Both these collectors found the plant in flower. In September 1968 the author paid a special visit to Ingwavuma Poort in order to obtain fruiting material of the species The precise locality had been given to the author by Professor Compton. The plant was found (in fruit) growing in a mixed community of *Portulacaria afra*, *Acacia* spp., *Combretum* spp., *Euclea schimperi* var. *daphnoides*, *Cladostemon kirkii*, *Balanites maughamii*, *Maerua rosmarinoides* etc. occurring on the southern side of the road about half way between the Swaziland–Natal border gate and the picnic spot amid fine specimens of *Acacia xanthophloea* on the banks of the Ingwavuma River at the foot of Cecil Mack's Pass.

NATAL.—Ingwavuma: Ingwavuma Poort, *Compton* 30088; *Killick* 3936.

SWAZILAND.—Lubombo: 2 miles N.E. of Big Bend, *Murdoch* 71.

M. brevipetiolata differs from *M. rosmarinoides* in the following respects: it is always a thin-stemmed scrambler whereas *M. rosmarinoides* can be a tree, shrub or sometimes a scrambler or climber; the leaves are Cerro green (Ridgeway) and arranged in one plane instead of very dark green and pendulous, and the leaflets are shorter and broader; the petioles are much shorter (hence the epithet *brevipetiolata*); the receptacle is campanulate rather than cylindric; the petals are reduced and the disc is annular and fimbrillate instead of lobed and unequally laciniate.

D. J. B. KILLICK

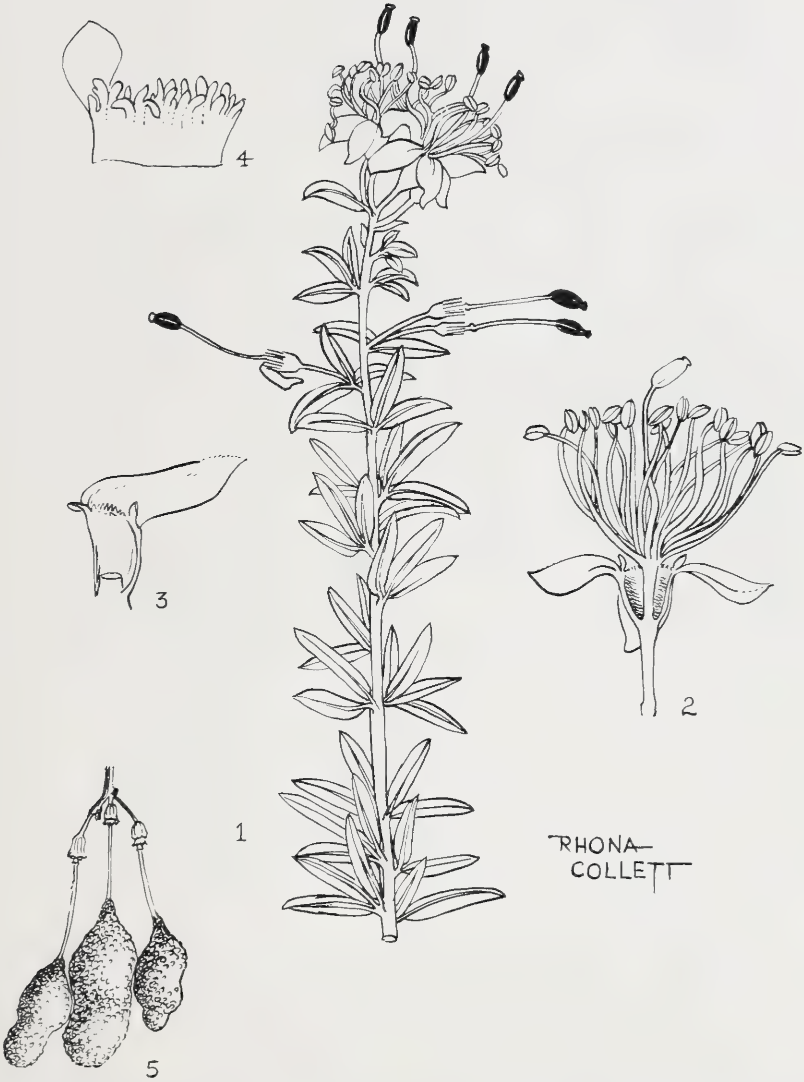

FIG. 2.—**Maerua brevipetiolata.** 1, flowering twig, natural size; 2, flower, × 2; 3, portion of receptacle showing disposition of disc, × 2; 4, disc, × 5; 5, fruit, natural size. 1–4, *Compton* 30088; 5, *Killick* 3936.

COMPOSITAE

A New Species of Schistostephium from the Natal Drakensberg

Schistostephium radicale *Killick & Claassen*, sp. nov. *S. griseo* (Harv.) Hutch. affine, sed plantis herbaceis parvioribus, foliis radicalibus subpectinatis, capitulis heterogamis differt.

Herba perennis, 5–6 cm alta, rhizomate ramoso subterraneo. *Caules* 1 vel plures, basi ramosi, conferti, cano-villosi. *Folia* alternalia, radicalia, subpectinata, petiolata; rhachis 1·6–6 cm longus; pinnae numerosae, lobis 1–5 secundis linearibus 1–2 mm longis; petioli 1·3–5 cm longi, basi amplexicaules. *Pedunculi* solitarii, elongati, filiformes, 12–15 cm longi, sparse foliosi. *Capitula* heterogama, disciformia, floribus marginis femineis, discique bisexualibus. *Involucrum* subhemisphaericum, 7–15 mm diam.; bracteae 3-seriatae; extimae subulatae, 4 mm longae, basi 1 mm latae, longociliatae; interiores spathulatae, marginibus apicibusque late scariosis, 5 mm longae, 1·5 mm late, ciliatae. *Receptaculum* planum vel nonnihil convexum, nudum. *Flores marginis*: dimidium inferiore tubulosum, 1·3 mm longum; superiore campanulatum, aequilongum; lobi 4, triangulares 1 mm longi, glandulosi; ovarium obovatum, 3 mm longum, compressum, anguste carinatum; stylus teretus, 1·5 mm longus, ramis oblongis truncatis 1 mm longis. *Pappus* 0. *Flores disci* floribus marginis similes, sed bisexuales; antherae lineari-oblongae, 1·8 mm longae, basi cuneatae, apice appendicibus ovatis. Fig. 3.

Type: Natal, Underberg, Sani Pass, locally common on rock outcrops in alpine grassland just below summit of Drakensberg, 8,900 feet, 25 January, 1966, *Killick & Vahrmeijer* 3760 (PRE, holo.).

Perennial herb, 5–6 cm high with branched underground rootstock giving rise to 1 or more basally branched tufted stems, grey villous. *Leaves* alternate, radical, compound, subpectinate, petiolate; rhachis 1·6–6 cm long; pinnae numerous; individual pinnae of 1–5 (from base and apex to middle) linear, secund lobes 1–2 mm long; petioles 1·3–5 cm long, amplexicaul at base. *Peduncles* solitary, elongate, filiform, 12–15 cm long, sparsely and minutely leafy. *Heads* heterogamous, many flowered, with marginal female florets and bisexual disc florets. *Involucre* hemispherical, flattish, 7–15 mm diam.; bracts in 3 rows; outermost bracts subulate, 4 mm long, 1 mm wide at base, long ciliate; inner bracts spathulate, margins and apex broadly scariose, 5 mm long, 1·5 mm wide, ciliate. *Receptacle* flat to somewhat convex, nude. *Marginal florets*: lower half tubular, 1·3 mm long; upper half campanulate, 1·3 mm long; lobes 4, triangular, 1 mm long, glandular; ovary obovate, 3 mm long, compressed, narrowly winged; style terete, 1·5 mm long, with oblong, truncate branches, 1 mm long. *Pappus* 0. *Disc florets*: identical with marginal florets but bisexual; anthers linear-oblong, 1·8 mm long, cuneate at base, with ovate apical appendage.

Known from only two localities in the Natal Drakensberg, namely Sani Pass and Giant's Castle Pass.

Natal.—Estcourt: rare in alpine grassveld in Giant's Castle Pass, alt. 9,000 feet, 23.1.1968, *Killick* 3907. Underberg: Sani Pass, *Killick & Vahrmeijer* 3760 (PRE, holo.).

The nearest affinity of *S. radicale* is *S. griseum* (Harv.) Hutch. These two species can be distinguished from all other species of *Schistostephium* by possessing solitary capitula borne on elongated peduncles. *S. radicale* differs from *S. griseum* in the following respects: the plant is a low-growing radical herb instead of a virgate suffrutex; the leaves are subpectinate with minute pinnae not more than 2 mm long, instead of pinnatipartite with pinnae up to 20 cm long and the capitula are heterogamous and not homogamous. The authors are indebted to Mr. E. G. H. Oliver, the Institute's iaison officer at Kew, for confirming that the plant is a new species.

D. J. B. Killick and C. G. T. Claassen

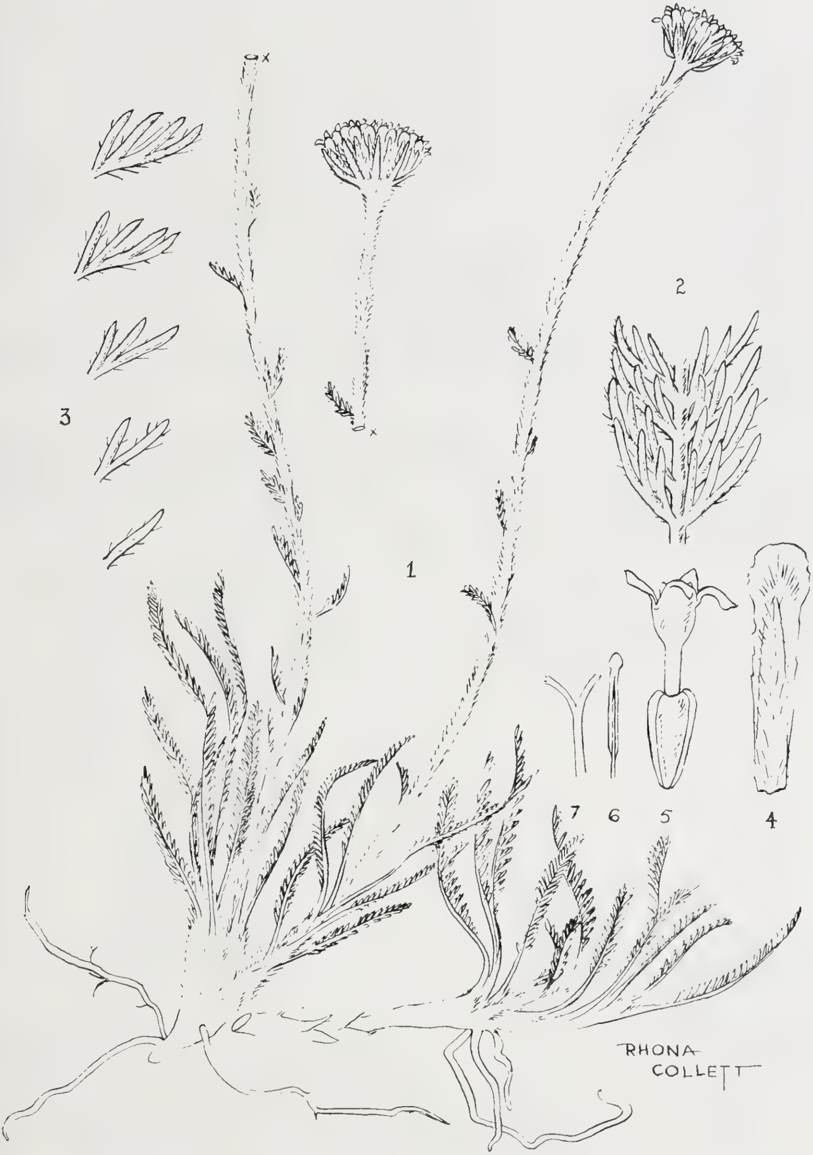

FIG. 3.—**Schistostephium radicale.** 1, habit, natural size; 2, portion of leaf; 3, 1–5-lobed pinnae; 4, inner involucral bract; 5, disc floret; 6, anther; 7, style. 2–7, × 6. All from *Killick & Vahrmeijer* 3760.

CRASSULACEAE

A Curious Form of Crassula natans Thunb. from the Natal Drakensberg

During a recent collecting expedition to the Loteni-Giant's Castle area of the Natal Drakensberg, the author discovered a curious aquatic *Crassula* (*Killick* 3869) common in pans at about 7500 ft (Fig. 4). At first it was thought that the plant might represent a new species: it could not be exactly matched in the National Herbarium, Pretoria, or at Kew. However, on closer examination of the plant, it was decided that it was merely a form of the extremely variable *Crassula natans* Thunb. It differs from typical *C. natans* and the known forms of the species as distinguished by Schonland in Ann. Bol. Herb. 2: 49 (1918) in that the stems are conspicuously swollen, fleshy and short-noded basally and filamentous and long-noded distally. Also, the terminal leaves are congested to form rosettes (which float on the surface of the water) and the flowers are terminal instead of being situated in the axils of the cauline leaves.

Dissection of a rosette revealed the following: the terminal leaves which are obovate and decussate have been congested through extreme abbreviation of the uppermost internodes; the flowers, though appearing terminal, are axillary with 1 or 2 flowers per leaf axil.

Two specimens in the National Herbarium from the south-western Cape approach *Killick* 3869 in growth form. *Andreae* 594 has a terminal rosette of leaves, but the stems are very much longer and scarcely swollen and fleshy at the base. *Drege* s.n. resembles *Andreae* 594, but the stems are distinctly swollen and fleshy at the base, although not as markedly as in *Killick* 3869.

The pans in which the Drakensberg plant occurs frequently dry up during winter, which may account for the fleshy nature of the basal part of the stems.

The petals of *Killick* 3869 are white, tinged with purple, the anthers are pale blue and the squamae are dark mauve. The carpels are 1-ovulate.

D. J. B. Killick

CRUCIFERAE

A New Combination in Silicularia

In continuation of my studies on the South African Cruciferae (see Bothalia 8: 166–169, 1964; 9: 97–112, 1966) it has been found necessary to make a new combination in the genus *Silicularia.*

Compton distinguished this genus from *Cycloptychis* on the 1-seeded, imperfectly septate fruits which are not beaked. In the absence of fruits it is not always easy to distinguish these genera from each other nor, indeed, from *Brachycarpaea*, *Schlechteria* or some species of *Heliophila.*

The very apt epithet of *S. sigillata* Compton has to be changed since it has been found to be conspecific with *Heliophila polygaloides* Schltr. based on *Schlechter* 8900 collected at an altitude of 5000 feet in the " Koude Bokkeveld " (Ceres distr.) on September 8th 1896. The new combination and its synonyms are as follows:

Silicularia polygaloides (*Schltr.*) *Marais*, comb. nov.

Heliophila polygaloides Schltr. in Bot. Jahrb. 27: 137 (1899), non Compton 1953. *H. nubigenoides* Compton in J. S. Afr. Bot. 19: 152 (1953), nom. illeg.

Silicularia sigillata Compton, l.c. 147, fig. 1a.

W. Marais

FIG. 4.—**Crassula natans** forma. 1 and 2, habit, × 2; 3, flower, × 10 (*Killick* 3869).

GRAMINEAE

A New Species of Eragrostis from South West Africa

Eragrostis pygmaea *De Winter*, sp. nov., affinis *E. kingesii* De Winter, sed spiculis minoribus, caryopside orbiculari embryone caryopsidem aequanti, foliius pilis longis mollibus obtectis facile distinguitur.

Gramen annuum, erectum vel suberectum, parvum. *Culmi* plerumque recti vel raro geniculati, 1-nodosi, non ramosi, sparsim pilosi. *Vaginae* pilosae. *Ligula* ciliata. *Foliorum laminae* expansae vel plicatae, nervis scabridis. *Panicula* subdense contracta, ramis solitariis vel binis angulatis scabridis rhachidi glandulosa. *Spiculae* virides vel flavae, 4–7 mm longae, 1–1·25 mm latae, 5–16-florae, glumis lemmatibusque maturitate deciduis paleis rhachidi tortuosa persitentibus; *glumae* inaequales, inferioribus quam superioriores brevioribus; lemmata navicularia, ovata, apice acuta, costa scabridiuscula, nervis lateralibus glabris eglandulosis. *Stamina* 3; antherae 0·2 mm longae, valde, late oblongae. *Caryopsis* orbicularis, opaca, pallide brunnea. Fig. 5.

Type: South West Africa, Swakopmund District, Cape Cross, ½ km from coast, *Giess* 8706 (PRE, holo.; K; M; US; WINDHOEK).

Erect or semi-erect annual up to 7 cm high. *Culms* unbranched, straight or more rarely geniculate, usually 1-noded, more rarely 2-noded, basal internodes short, glabrous, upper ones with scattered long soft bulbous-based hairs, without glands below the nodes. *Sheaths* chartaceous to almost membranous, lax, with scattered bulbous-based hairs between the ribs, eglandular. *Ligule* a fringe of stiff hairs. *Collar* very inconspicuous. *Leaf-blade* expanded, up to 2 cm long and 3 mm wide, with long bulbous-based hairs mainly between the nerves below and sparsely scabrid on the nerves on both surfaces, eglandular. *Panicle* moderately to densely contracted, rigid, erect, 2–4 cm long and 1·0–1·5 cm wide; rhachis ribbed, scabrid on the ribs with a few scattered bulbous-based hairs, glands usually present below the point of junction between branches and rhachis; branches single or 2–3 together, bearing branchlets from near the base. *Spikelets* bright green to pallid, about 4–7 mm long and 1–1·25 mm wide, 5–16-flowered, breaking up from below, glumes and lemmas deciduous at maturity leaving the zig-zag rhachis with the pales attached to it. *Glumes* unequal, the lower shorter than the upper, each much shorter than the lemma it subtends, one-nerved, boat-shaped, lower about 0·75 mm, upper 1–1·25 mm long, scabrid on the keels. *Lemmas* boat-shaped, broadly ovate when flattened, 1·5 mm long and 1·0 mm wide, 3-nerved, nerves prominent, smooth except for the keels which are scabrid. *Pales* slightly more than half the length of the lemmas, 2-keeled, the keels strongly curved and scabrid. *Lodicules* 2, cuneate, fleshy, 0·2 mm long. *Stamens* 3; anthers 0·2 mm long, very broadly oblong, purple in colour. *Ovary* glabrous, styles distinct, stigmas plumose. *Caryopsis* opaque, orbicular, very smooth, pale brown. *Embryo* nearly as long as the grain. *Hilum* punctiform, basal.

This minute annual is found in shallow depressions on sandy flats in the central and coastal Namib Desert of South West Africa. This area has an average annual rainfall of about half an inch only and many years may pass without any rains falling at all, in particular localities.

After rains, these plants shoot up and flower and fruit with amazing rapidity. Development may be completed with the moisture available from only one shower. Heavy sea mists are, however, experienced at and up to 20 miles from the coast. It is possible that these plants derive some benefit from the mist by being moistened.

South West Africa.—Omaruru: south of the Mesemberge, *Giess* 9651. Swakopmund: 10 miles east of Henties Bay on road to Usakos, *De Winter & Hardy* 8050; Cape Cross, ½ km from coast, *Giess* 8706.

E. pygmaea is closely allied to, but easily distinguished from *E. kingesii.* The latter is apparently confined to the deserts around Luderitz south of the high sand dunes, which lie between Luderitz and Walvis Bay, while *E. pygmaea*, on the other hand, has so far only been found north of the high sand dunes.

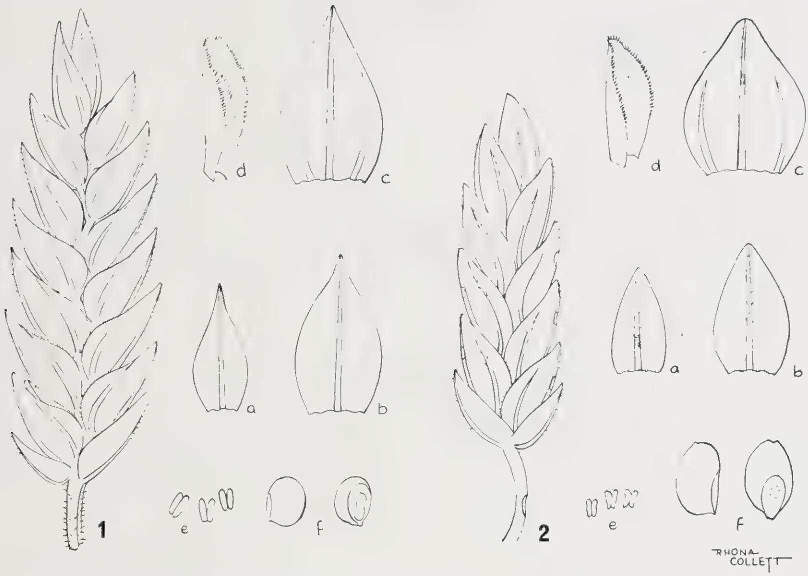

FIG. 5.—1, **Eragrostis pygmaea,** spikelet, × 10 (*De Winter & Hardy* 8050). 2, **E. kingesii,** spikelet, × 10 (*Kinges* 2236). a, lower glume; b, upper glume; c, lemma; d, palea; e, anthers; f, mature caryopsis (all × 15).

The type material was collected by Mr. W. Giess, who kindly made his material available for description when he suspected it to be new. The *De Winter & Hardy* collection consists of only one sheet, because this was the only material available at the time of collecting and is hence only represented in PRE.

B. DE WINTER

A NEW GENERIC RECORD FOR SOUTH AFRICA

During January 1966, while plant collecting in the Southern Drakensberg, Dr. D. J. B. Killick and Mr. J. H. Vahrmeijer found a small aquatic grass common in a seepage area at the top of the Sani Pass (c. 9,000 ft) very close to the Lesotho border. The grass was identified as *Catabrosa aquatica* (L.) Beauv. and this was subsequently confirmed by Dr. B. de Winter at Kew.

The gathering, *Killick & Vahrmeijer* 3730, represents a new generic record for South Africa. *C. aquatica* is known from Europe, temperate Asia, North America and North-west Africa, where it is found in moist places usually at fairly high altitudes.

It is a stoloniferous perennial with culms 10–40 cm tall, usually rooting from the lower nodes. The leaf-blades are up to 10 cm long, 2–8 mm wide and with a membranous ligule. The inflorescence consists of an open, ovate to oblong, panicle. 3–10 cm long with the branches spreading in somewhat distant whorls. The yellow to green or brown spikelets are borne on short pedicels and are approximately 3 mm long with 1–3 florets.

The occurrence of this grass so far from its chiefly temperate abode poses an interesting problem of distribution. It may be that with further plant exploration the grass will be found on the mountains of tropical east Africa, a common migration route for temperate plants including grass species such as *Aira caryophyllea* L., *Koeleria cristata* (L.) Pers. and the genera *Anthoxanthum* and *Deschampsia.*

J. G. Anderson

LILIACEAE

Haworthia koelmaniorum: A Correction

Haworthia koelmaniorum *Oberm. & Hardy*

In Flowering Plants of Africa, 38: t. 1502 (1968) the epithet of this newly described *Haworthia* was inadvertently given the wrong ending (viz. *koelmaniora*). It is herewith amended to *H. koelmaniorum*, to commemorate its discovery by the Koelman family.

A. A. Obermeyer

MALVACEAE

A New Combination in Pavonia

Pavonia senegalensis (*Cav.*) *Leistner*, comb. nov.

Hibiscus senegalensis Cav., Diss. 3: 160 (1787). Type: Senegal, *Adanson* s.n. (MA, holo.!). *H. baumii* Guerke in Warburg, Kunene–Sambesi Exped. 299 (1903). Type: Angola, Cuito River, *Baum* 760 (B, holo.†, Z!).

Pavonia hirsuta Guill. & Perr. in Guill., Perr. & A. Rich., Fl. Senegamb. Tent. 1: 51 (1831). Type: Senegal, Safal, *Leprieur* s.n. (P, holo.!). ——var. *microphylla* Ulbr. in Bot. Jahrb. 57: 117 (1920); var. *β*. Guill. & Perr. in Guill., Perr. & A. Rich., Fl. Senegamb. Tent. 1: 51 (1831). Type: Senegal, Perrottet " No. 1 " (P, holo.!). *B. insignis* Fenzl ex Webb, Fragm. Fl. Aethiop. 42 (1854). Type: Sudan, Cordofan, *Kotschy* 216 (P!). *P. zawadae* Ulbr. in Bot. Jahrb. 48: 371 (1912). Syntypes: S.W. Africa, Arub, *Zawada* sub Dinter 1347; Omantumba, *Dinter* 3323; Caprivi Strip, near Sesheke, *Seiner* 48, 64 (B†).

On examining the type of *Hibiscus senegalensis* Cav. in Madrid it became clear that *Pavonia hirsuta* Guill. & Perr. is conspecific. The area of the species extends from the Sudan and Senegal to northern South West Africa and the northern Cape. Although no cited material of *P. zawadae* was seen, it is clear, from the very detailed original description, that this species cannot be separated from *P. senegalensis.*

O. A. Leistner

SELAGINACEAE

A New Species of Selago

Selago trauseldii *Killick*, sp. nov., nulla affinitate arcte obvia.

Plantae perennes, lignosae, erectae, c. 60 cm altae, interdum basi ramosae, caulibus pubescentibus. *Folia* fasciculata, conferta, elliptica, 4–6 mm longa, 1–1·5 mm lata, puberula. *Capitula* subglobosa, floribus densis, 7 mm diam., in corymbum disposita. *Bracteae* 7–10, anguste ovatae vel subulatae, 4·5 mm longae, 1·5 mm latae, concavae, puberulae. *Calyx* tubulosus, 5 mm longus nonnihil bilabiatus; lobi inaequales, lineari-

subulati, ciliati, lobis anticis duobus 1 mm longis, lobo postico 3 mm longo, lobis lateralibus duobus 2 mm longis. *Corolla* tubulosa, alba vel pallide purpurea, nonnihil bilabiata; tubus cylindricus, basin versus angustatus, 4–5 mm longus; labellum anticum 2-lobatum, lobis late ellipticis, 2 mm longis, 1·3 mm latis. *Stamina* 4, didynama, superioribus 1·5 mm longis, inferioribus 1·8 mm longis; antherae 0·6 mm longae, medifixae. *Ovarium* ellipsoideum vel obovoideum, 0·8 mm longum, 2-loculare; ovula in quoque loculo 1; stylus tenuis, 3·5 mm longus, stigmate simplici. FIG. 6.

FIG. 6.—**Selago trauseldii.** 1, single capitulum, × 5; 2, bract, × 7; 3, calyx, × 7; 4, corolla opened out, × 7; 5, pistil, × 7 (*Killick* 1637).

Type: Natal, Bergville District, Cathedral Peak Forest Research Station, Indumeni Valley, 6650 feet, 11 January, 1952, *Killick* 1637 (PRE, holo.).

Plants perennial, woody, erect, about 60 cm tall, sometimes branched at the base, stems pubescent. *Leaves* fasciculate, crowded, elliptic, 4–6 mm long, 1–1·5 mm wide, puberulous. *Heads* subglobose, densely flowered, 7 mm diam., arranged in corymbs. *Bracts* 7–10, narrowly ovate to subulate, 4·5 mm long, 1·5 mm wide, concave, puberulous. *Calyx* tubular, 5 mm long, somewhat bilabiate; lobes unequal, linear-subulate, ciliate, 2 anticous lobes 1 mm long, posticous lobe 3 mm long, 2 lateral lobes 2 mm long. *Corolla* tubular, white or pale purple, somewhat bilabiate; tube cylindrical, narrowed towards the base, 4–5 mm long; anticous lip 2-lobed, lobes usually elliptic, 1·5 mm long, 1·2 mm wide; posticous lip 3-lobed, lobes broadly elliptic, 2 mm long, 1·3 mm wide. *Stamens* 4, didynamous, upper 1·5 mm long, lower 1·8 mm long; anthers 0·6 mm long, medifixed. *Ovary* ellipsoid-obovoid, 0·8 mm long, 2-locular; ovules 1 in each locule; style slender, 3·5 mm long, stigma simple.

Selago trauseldii is known from only two localities in the Drakensberg: it was first collected by the author in the Cathedral Peak area in 1952 and then 15 years later by Mr. W. R. Trauseld in the Giant's Castle Game Reserve further south. In both areas it grows in *Themeda triandra* Grassland on the Little Berg. The plant flowers from Janauary to March.

NATAL.—Bergville: Cathedral Peak Forest Research Station, *Killick* 1637. Estcourt: Giant's Castle Game Reserve, *Trauseld* 751.

With its rigid, erect habit and round heads arranged to form a corymbose inflorescence, *S. trauseldii* is a distinct species with no obviously close ally. The flower colour is variable: in the Cathedral Peak specimens the flowers are pale purple, while in the Giant's Castle specimens they are white. The species has been named in honour of Mr. Trauseld who, through his collectings, has added so much to our knowledge of the flora of the Natal Drakensberg.

D. J. B. Killick

STERCULIACEAE

A New Species of Hermannia

Hermannia umbratica *Verdoorn*, sp. nov., *H. malvaefoliae* praecipue foliis cordatis accedens sed inter alia floribus minoribus geminatis, petalis glabratis differt.

Planta procumbens; rami tenues, rami, petioli, pedunculi et pedicelli stellato-pubescentes saepe pilis brevibus vel longis pluri-cellularis apice glanddulosis immixtis. *Stipula* oblonga, oblongo-lanceolata vel deltoideo-oblonga, nonnunquam lobata, 2–6 mm longa, stellato-pubescens pilis brevibus apice glandulosis immixtis. *Folia* ovato-oblonga vel suborbiculata, basi cordata, margine crenata, supra sparse stellato-pubescentia, infra grosse stellato-pubescentia et minute papillosa; petiolus 4–16 mm longus. *Inflorescentia* 2-flora, folia opposita; pedunculi 10–20 mm longi; pedicelli 2–12 mm longi, ad apicem cernui; bracti plerumque 3, 1–2·5 mm longi. *Calyx* circa 3·5 mm longa, quasi medium quinquefidus sparse stellato-pubescens pilis brevibus apice glandulosis immixtis. *Petala* lutea, anguste obovata, 5–6 mm longa, leviter ad medium angustata, ultra medium margine inflexa glabra. *Stamina* filamentis cruciatis, 1·5 mm longis, lobis lateralibus apice setosis; antheris 2 mm longis, acutis sparse ciliatis. *Ovarium* stellato-tomentosum. *Capsula* tenuiter stellato-tomentosa circiter 3·5 mm longa, lobis obtusis. *Semina* reniformia, laevigata, nigra hilo albido.

Type: Transvaal, Potigetersrus, Pyramid Estate, *Galpin* 8924 (PRE, holo.).

Procumbent plant with slender branches, the branches, petioles, peduncles and pedicels stellate-pubescent with long, many-celled, gland-tipped hairs intermixed, often one or other of these types of hairs predominant. *Stipules* oblong, oblong-lanceolate or deltoid oblong, sometimes oblique and rarely 2–3-lobed, 2–6 mm long, stellate-pubescent with short gland-tipped hairs intermixed. *Leaves* ovate-oblong to suborbicular, cordate, margins irregularly crenate, upper surface sparsely pubescent with 1–3-rayed stellate hairs, under surface coarsely pubescent with several-rayed stellate hairs; petiole 4–16 mm long. *Inflorescence* leaf-opposed, geminate; peduncle 16–20 mm long; pedicel 2–12 mm, cernuous near the apex; bracts usually 3, 1–2·5 mm long. *Calyx* about 3·5 mm long, lobed to just beyond the middle, sparsely pubescent with stellate and short gland-tipped hairs; tube widely campanulate; lobes about 1·5 mm long, more or less deltoid. *Petals* yellow, rather narrowly obovate, 5–6 mm long, lower half with narrowly inrolled margins, glabrous. *Stamens* with cruciform filaments, about 1·5 mm long, lateral arms with apical setae; anthers about 2 mm long, acute, sparsely ciliate. *Ovary* stellate-tomentose; styles slender, erect. *Capsule* thinly stellate-tomentose, about 3·5 mm long, enclosed in the faded calyx and corolla, carpels rounded at the apex. *Seeds* reniform, smooth, black with a conspicuous whitish hilum.

Found in shade on rocky slopes in the dry wooded country of the central Transvaal. Recorded from the Pretoria, Potgietersrus and Lydenburg districts.

Transvaal.—Pretoria: Wonderboom Poort, *C. A. Smith* 6153. Potgietersrus: Pyramid Estate, *Galpin* 8924 (type). Lydenburg: near Steelpoort, *Codd & Dyer* 7725.

This species resembles *H. malvaefolia* in the trailing habit, slender stems and cordate leaves. It differs in several respects which are not readily detected, such as the leaves in *H. malvaefolia* being more orbicular, mostly broader than long and more regularly crenate; the flowers usually solitary and slightly larger, 8–10 mm long, and the petals distinctly pubescent dorsally. *H. malvaefolia* is found on the high mountains in the eastern escarpment at altitudes above 5500 ft in contrast with the dry wooded country of the central Transvaal from which our species comes.

The late Mr. N. Pillans recognized this as an undescribed species and it would have been a pleasure to name it in his honour but the epithet " pillansii " has already been used in *Hermannia.* Collectors' notes on all the specimens seen mentioned that the plants grew in the shade and this suggested the name *H. umbratica.*

I. C. Verdoorn

New Names in Hermannia

Hermannia antonii *Verdoorn*, nom. nov.

H. rehmannii (Szyszyl.) K. Schum. in Engl. Mon. Afr. Pflanz. 5: 76 (1900), nom. illeg., non Szyszyl. (1887).

Mahernia rehmannii Szyszyl. Polypet. Thalam. Rehm. 147 (1887). Type: Transvaal, *Rehmann* 6648 (K, Z).

Szyszylowicz described both *Hermannia rehmannii* and *Mahernia rehamnnii* in 1887 when working on the plants collected by Anton Rehmann in South Africa. The syntypes of the *Hermannia* were collected in the Cape and the Orange Free State, while the *Mahernia* came from the Transvaal highveld. *Hermannia rehmannii*, the Cape species, has been found to be conspecific with *H. bryoniifolia* Burch. (1824). Schumann in Engler's Mon. Afr. Pflanz. 5: 56 recognized this and placed it in synonymy under *H. bryoniifolia.* In the same publication, Schumann transferred *Mahernia rehmannii* to the genus *Hermannia*, making the combination *H. rehmannii* (Szyszyl.) K. Schum. According to present day rules of nomenclature, this is not permissible and the species is therefore now given a new name using, for historical purposes, Rehmann's Christian name.

Incidentally, it may be helpful to mention, firstly, that Schumann, when making the combination *H. rehmannii*, placed *H. brachymalla* in synonymy, but today these are recognized as distinct species; and, secondly, under *H. bryoniifolia* he cites *Rehmann* 3249 as coming from the Transvaal which is incorrect. The Rietpoort given as the locality could not be in the Transvaal, not only because the species does not occur there, but because of the low collector's number, 3249. By the time Rehmann reached the Transvaal his numbers were all in the six thousands.

Hermannia repetenda *Verdoorn*, nom. nov. *H. hirsuta* Schrad. et Wendl., Sert. Hannov. 10, t. 4 (1795–1798), nom. illeg., non Mill. (1768).

Miller's *Hermannia hirsuta* obviously describes *Hermannia althaeifolia* L. and has been placed in synonymy under that species.

The later homonym, *H. hirsuta* Schrad. & Wendl., here given the new name *H. repetenda* (meaning regained or come upon again), was described from plants flowering in the " Herrenhäuser Gärten ", Hannover, the seed having come from the Cape of Good Hope. A figure accompanies the description and from this, together with type material preserved in the Stockholm, Leningrad and Göttingen herbaria, the species is readily identified. It is, however very rarely found represented in herbaria today but a recent search for the species in the wild by the author has revealed that it occurs in the Van Rhyns Pass, the Pakhuis Pass and on the Piketberg in the western Cape Province. Its scarcity in herbaria may be attributed to its being palatable to stock and thus seldom found by collectors.

FIG. 7.—**Hermannia cuneifolia** var. **glabrescens.** 1, upper portion of a branch, × 1; 2, leaf, × 7; 3, flower, × 7; 4, petal, × 7; 5, stamens surrounding the ovary, × 7; 6, stamens, × 7; 7, ovary and styles, × 7 (*Smith* 4407).

A wrong application of the name was commended by Harvey who in the Flora Capensis (1860) mistakenly cited a figure, Jacquin, Schoenbr t. 127, as a synonym of *H. hirsuta* Schrad. & Wendl. This figure represents a closely related but specifically distinct species which is found abundantly in herbaria (not palatable?) and which is, today, recognized as *H. aspera* Wendl. Jacquin had mistakenly called it *H. scabra* Cav.

I. C. Verdoorn

New Combinations in the Genus Hermannia

Hermannia burchellii (*Sweet*) *Verdoorn*, comb. nov.

Mahernia burchellii Sweet, Hort. Brit. ed. 1: 57 (1827). Type: Plate 224, Bot. Reg. 3 (1817). *M. grandiflora* sensu Ker Gawl. in Bot. Reg. 3: t.244 (1817), partly, as to description, plate and *Burchell* 2333; Harv. in Fl. Cap. 1: 217 (1860), partly, as to *Burchell* 2333. ——var. *burchellii* Harv., l.c. (1860). Type: Plate 224, Bot. Reg. 3 (1817).

The specimen figured in the Botanical Register, plate 224 (1817), was taken from a plant introduced by William Burchell from South Africa and raised in a London nursery. Burchell is quoted as writing that it came originally from the " vast sandy plains northwards of the town of Litakuun ", that is north-east of the present-day Kuruman. In that publication the specimen is wrongly identified as being conspecific with *Hermannia grandiflora* Ait., which was introduced by Masson some years earlier and differs, among other things, in having the leaves glabrous or fairly sparsely glandular pubescent and rather deeply lobed on the margins, instead of densely setellate-pubescent to tomentose at least on the lower surface and shallowly crenate on the margins. The flowers of the two species are very similar and if the genus *Mahernia* were maintained they would, on account of the filaments, be placed in that genus. This accounts for the combination *Mahernia grandiflora* (Ait.) Burch. ex Ker Gawl. in the Botanical Register. Masson's species, *H. grandiflora*, is restricted to the Karoo between the Laingsburg and Carnarvon districts whereas Burchell's species is found only in the Kalahari north of the Orange River which Masson did not reach. The painting in Paterson's " Travels " facing page 60, which is also cited in the Botanical Register as being the same species as Burchell's plant, is *Hermannia stricta* (E. Mey. ex Turcz.) Harv., found only along the lower reaches of the Orange River. It has flowers resembling *H. grandiflora* and *H. burchellii*, but is not closely related, differing in the type of inflorescence and the long-horned capsules.

Hermannia cuneifolia *Jacq.* var. **glabrescens** (*Harv.*) *Verdoorn*, comb. nov. Lectotype: *Drege* s.n. (K!).

H. pallens Eckl. & Zeyh. var. *glabrescens* Harv. in Fl. Cap. 1: 190 (1860), partly, as to *Drege* specimen labelled *H. multiflora* and annotated by Harvey as a variety of *H. pallens*, excl. *Barber* s.n. in Herb. Hook. (K).

When reviewing the genus *Hermannia* for the Flora of Southern Africa it was found that *H. pallens* Eckl. & Zeyh. (1835) is synonymous with the earlier species *H. cuneifolia* Jacq. (1797). It was also found that the species may be separated into two groups of varietal rank with more or less distinct areas of distribution, overlapping only on the borders. This necessitated a clear definition of the variety *H. pallens* var. *glabrescens* Harv.

When describing this variety Harvey cited two specimens, one collected by Drege and the other by Mrs. Barber. On inspecting these sheets, sent on loan from Kew, it was found that the Drege specimen, which happens to be mentioned first under the variety, best matched the diagnosis which reads " leaves glabrescent, very sparingly

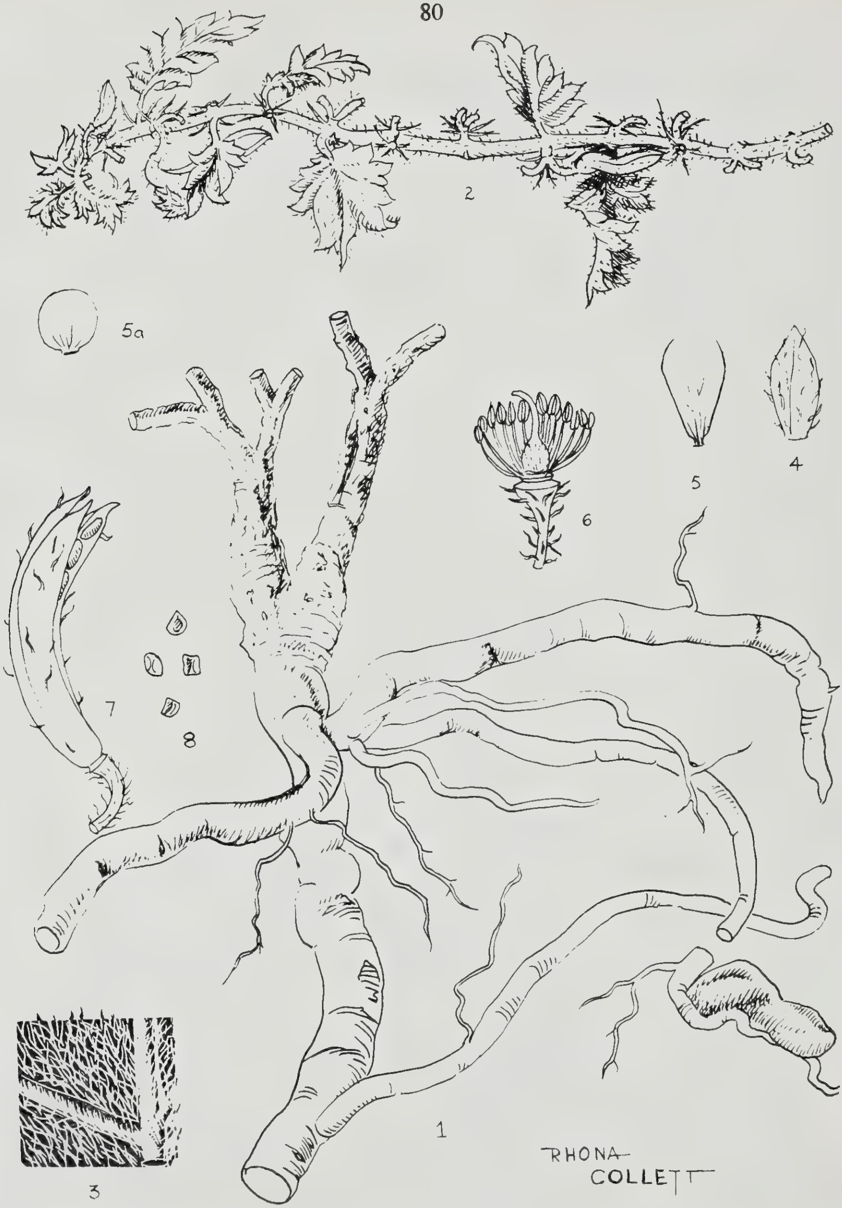

FIG. 8.—**Corchorus sulcatus.** 1, rootstock and in bottom right-hand corner a small stone to illustrate how the roots curved around and under the loose stones; 2, upper portion of a prostrate branch, showing the persistent peduncles and pedicels from which the fruits have fallen; 3, section of the under surface of leaf, × 7; 4, sepal × 3; 5, obovate petal, × 3; 5a, suborbicular petal from neighbouring flower × 3; 6, androgynophore bearing stamens and ovary × 3; 7, capsule × 2; 8, seed × 2.

scaly ". The specimen collected by Mrs. Barber in the type locality of *H. pallens* is obviously merely an odd specimen of the typical variety, differing in that it has a few leaves which are glabrescent on the upper surface, but they are densely " scaly " (lepidote stellate) below. The Drege specimen on which the leaves are " sparingly scaly " and the label bears the words " *H. pallens* var. *subglabra* " in Harvey's handwriting is therefore here selected as the type of Harvey's variety. It happens to match the group presently segregated as a variety and found mainly in the transitional zone between Karoo and grassland, which stretches roughly from the vicinity of Beaufort West north-eastwards in a widening band through Middelburg to Aliwal North and through Herbert district into the Orange Free State, reaching Lesotho in the east. The locality where Drege collected the type specimen is by implication the " Hexrivierbergen " for in Zwei Documenta that is given as the only locality for Drege's concept of *H. multiflora*. This is to the south-west of the area of distribution of the variety as indicated by the presently available material. There may be some uncertainty about the exact locality of the Drege specimen, but there is no doubt about its identification. It is conceivable that further specimens may be found outside the main distribution area.

H. cuneifolia var. *glabrescens* differs from the typical variety in the shrublets being generally 30–40 cm tall, more repeatedly branched, the branchlets shorter, rigid and early glabrescent; the leaves more sparsely lepidote-stellate; the inflorescence congested at the apices of numerous, short, lateral twigs, usually with only 3 to 5 flowers in each; flowers smaller, just over 5 mm long (instead of 8–10 mm long); the calyx more narrowly campanulate and slightly narrowed at the throat; and the petals glabrous or nearly so and cuneate into the claw instead of being distinctly ciliate to densely pubescent along the margins and abruptly narrowed into the claw.

Cape.—Ceres: Bokkeveld, Hexrivier Mts.?, *Drege* s.n. (K, lecto., W); Beaufort West: Nieuwveld Mts., *Esterhuysen* 2748; Sunnyside, *Esterhuysen* 5056. Murraysburg: *Van Heerden* 1. Cradock: *Brynard* 43; *Long* 770; 772; Modderfontein, *Acocks* 12811. Middelburg: *Horn* s.n.; Conway Farm, *Gilfillan* in herb. Galpin 2955; 5507. Richmond: Leopards' Vlei, *Bolus* 15341. Colesberg: *Botha* in Bloemfontein Univ. Herb. 7547. Aliwal North: *Thode* A1840. Herbert: Thornhill, *Leistner* 1422.

O.F.S.—Philippolis: *Smith* 4485; 4497. Rouxville: *Ecklon & Zeyher* loc. 114 in Linnaea 19. Zastron: *Maree* 1. Fauresmith: *Smith* 413; 429a; 4344; 4373; 4407; 4430; 4541; *Henrici* 1815; 1864; *Verdoorn* 1140. Thaba Nchu: *Roberts* 2666. Bloemfontein: *Gemmell* in Bloemfontein Univ. 6440; *Thode* A521.

Lesotho.—Leribe: *Dieterlen* 755.

TILIACEAE

A New Species of Corchorus

Corchorus sulcatus *Verdoorn*, sp. nov. *C. asplenifolio* Burch. affinis, sed foliis subtus dense sericeo-villosis, a *C. confuso* Wild pedicellis fructuosis valde recurvis differt.

Planta perennis, caulorhiza lignosa, ramulis prostratis sericeis vel sericeovillosis. *Folia* petiolata; lamina sulcata, ovata, subrotunda, vel anguste ovato-oblonga, 1–3·2 cm longa, 4–16 mm lata, supra sericea vel sparse villosa, glabriuscula, infra dense adpressa sericeo-villosa, margine crenato-dentata, nervis lateralibus supra valde impressi infra prominentibus; petioli 2–10 mm longi, sericei vel villosi. *Cymae* 1–3-florae, suboppositifoliae, subsessiles vel pedunculis 1·5 mm longis, villosis; pedicelli 1–4 mm longi, villosi; bracteae anguste lineares, acuminatae, sparse pilosae. *Alabastra* subglobosa, sericea vel villosa, minute mucronata. *Sepala* anguste lanceolato-elliptica, c. 6 mm longa, 1·75 mm lata, extus pilosa. *Petala* flava, obovata, sepalis subaequilonga, 6 mm longa, 2 mm lata (interdum petala suborbicularia, sepalis breviores, 1·75 mm lata), basi breviter unguiculata ungue parçe ciliato. *Androgynophorum* c. 0·75 mm altum; stamina numerosa, filamentis 4 mm longis, antheris 0·75 mm longis. *Ovarium*

3-loculare, anguste oblongo-ellipticum, strigosum; stylus c. 4 mm longus, glabriusculus. *Capsula* cylindrica subarcuata, strigosa vel villosa 15–25 mm longa, 2–2·5 mm diam., trivalvis, pedunculo 2 mm longo, pedicellis valde recurvatis c. 4 mm longis. FIG. 8.

Type: Transvaal, Potgietersrus District, 10 miles south of Roedtan, *Codd & Verdoorn* 10376 (PRE, holo.).

Perennial with a woody rootstock, branches short, usually under 30 cm long, prostrate, sericeus or sericeo-villous. *Leaves* petioled; lamina sulcate between the lateral impressed nerves, ovate, subrotund or narrowly ovate-oblong, 1–3·2 cm long, 4–16 mm wide, upper surface sericeous or sparsely villous becoming almost glabrous, lower surface densely and persistently appressedly sericeo-villous, margins crenate-dentate, lateral nerves deeply impressed on the upper surface, prominent beneath; petiole 2–10 mm long, sericeous or villous. *Cymes* 1–3-flowered, sub-opposite the leaves, subsessile or with a peduncle up to 1·5 mm long, villous; pedicels 1–4 mm long, villous; bracts narrowly linear, acuminate, sparsely pilose. *Buds* subglobose, sericeous or villous, minutely mucronate. *Sepals* narrowly lanceolate-elliptic, c. 6 mm long, 1·75 mm broad, pilose without. *Petals* yellow, obovate about as long as the sepals, 6 mm long, 2 mm broad (on some flowers petals suborbicular and shorter than the sepals, 1·75 mm broad), shortly clawed, claw very sparsely and minutely ciliate. *Androgynophore* about 0·75 mm long; stamens numerous with filaments about 4 mm long, anthers 0·75 mm long. *Ovary* 3-locular, narrowly oblong-elliptic densely strigose; style about 4 mm long, more or less glabrous. *Capsule* cylindric, somewhat curved, strigose or villous, 15–25 mm long, 2–2·5 mm diam., 3-valved; fruiting peduncle 2 mm long, pedicels strongly recurved, c. 4 mm long, persistent.

In the Transvaal this species was found growing scattered on an extensive limestone outcrop about ten miles south of Roedtan on the Marble Hall road. It occurred quite frequently in this patch and the roots were found to be curling over and under the rounded stones common in this formation. Growing with it in the same area was *Melhania griquensis* which is found commonly on limestone outcrops in Griqualand West. It is, therefore, not surprising that a specimen from the Barkly West area collected on limestone. was found to agree with the Roedtan specimens.

CAPE.—Barkly West: Gong Gong, *Acocks* 1445.
TRANSVAAL.—Potgietersrus: 10 miles south of Roedtan, *Codd & Verdoorn* 10376; *Verdoorn* 2511.

In nature the dark green leaves spread out from the prostrate branchlets with face upwards showing the characteristic sulcate surface caused by the deeply impressed lateral veins. On pressed specimens the corrugations disappear to a certain extent, but there are usually some leaves on each specimen showing this feature. The under surface of the leaf is densely and persistently covered with long, silky appressed hairs. On the Cape specimen this pubescence tends to be sericeous, that is silky and appressed, whereas in the Transvaal specimens it is sericeo-villose, the hairs being slightly curly or wavy and not so obviously silky.

C. sulcatus approaches the variable species *C. asplenifolia* in the procumbent habit and the similarly shaped capsules borne on strongly recurved pedicels. It is distinguished from it mainly by the pubescence on the under surface of the leaves, their shape and the usually shorter more permanently prostrate branches. In *C. asplenifolia* the leaves are narrowly oblong-lanceolate to almost linear and glabrous to hispid with bulbous-based hairs, whereas in *C. sulcatus* they are ovate to narrowly ovate-oblong and, as stated above, densely, persistently sericeo-villous beneath.

Bothalia 10, 1: 83–88

New and Interesting Records of South African Fungi, Part VI

by

G. C. A. van der Westhuizen* and K. T. van Warmelo*

Abstract

Six species of fungi, recorded for the first time in South Africa, are described. The species are *Gelasinospora cerealis* Dowding from roots of *Eucalyptus saligna*; *Spegazzinia tessarthra* (B. & C.) Saccardo from *Zea mays*; *Melampsora larici-populina* Klebahn from *Populus deltoides*; *Saccobolus depauperatus* (Berk. & Br.) Phill. from horse dung; *Humicola stellata* Bunce from grass hay and *Chaetomium cochliodes* Palliser from garden soil.

Six species are described and discussed below. Dried down cultures or specimens on natural substrata of all these species have been deposited in the mycological collection of the National Herbarium (PRE), at 590 Vermeulen Street, Pretoria.

1. **Gelasinospora cerealis** *Dowding* in Can. J. Res. C. 9: 295 (1933); Cain, ibid. 28: 566 (1950); Von Arx and Müller, Beitr. Kryptogamenfl. Schweiz 11: 293 (1954).

Figures : 1, 2, 3, 4.

On potato-dextrose agar colonies grow rapidly covering the plate in 3–4 days and forming a cottony to woolly, white mycelial mat. Perithecia single or cespitose, superficial or with base partly immersed, dark brown or black, pyriform, bare over upper parts but with dense mycelium towards the base, $800–1100 \times 600–900\mu$; neck papilliform $180–250\mu$ long and $180–250\mu$ wide at the base, ostiolate and lined with periphyses; wall thick coriaceous composed of dark-brown, angular cells externally and subhyaline cells in the inner layers. Asci cylindrical, hyaline, unitunicate, truncate and distinctly perforate at the apex tapering below into a fairly short stipe, $175–280 \times 22 \cdot 5–37 \cdot 0\mu$, eight spored, or, sterile olivaceous-brown, thick-walled and pitted, $137–205 \times 20–25\mu$; paraphyses lacking but hyaline, irregular, elongate, thin-walled, cells and narrow, hyaline thin-walled filaments up to $3 \cdot 0\mu$ in diameter are present among the asci. Ascospores uniseriate, hyaline at first soon darkening to pale brown or olivaceous and developing a thick pitted epispore which darkens to deep olivaceous black, finally opaque, broadly ellipsoid, rounded at the ends, occasionally slightly apiculate at one end, $25–40 \times 20–27 \cdot 5$ μ mostly $32 \times 25\mu$.

Specimen examined: PRE 43070, (Mycological Herbarium) on potato-dextrose agar, isolated from diseased roots of *Eucalyptus saligna*, Tzaneen, Northern Transvaal, March 1964.

The dark-coloured ascospores with thick, pitted epispore of this fungus are characteristic of the genus *Gelasinospora* Dowding of which four species have been described. These have been recorded on dung, roots and stems of various plants (Von Arx and Müller, *l.c.*).

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Explanation of Figures

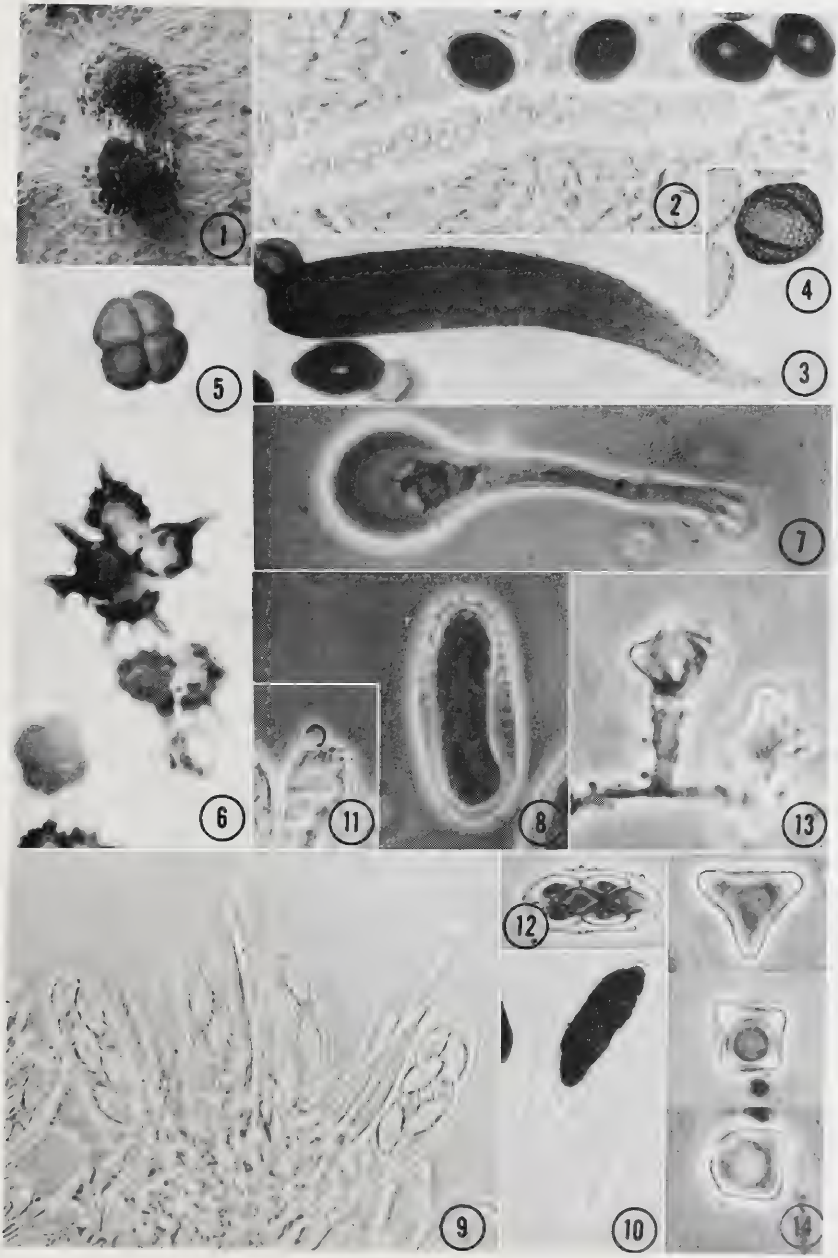
Fig. 1–4.—**Gelasinospora cerealis.** Fig. 1, perithecia (× 15). Fig. 2, young ascus and ascospores (× 400). Fig. 3, dark coloured, sterile ascus (× 400). Fig. 4, maturing ascospore showing pitted epispore (× 500).

Fig. 5–6.—**Spegazzinia tessarthra.** Fig. 5, conidium without spines (× 500). Fig. 6, echinulate conidium (× 500).

Fig. 7–8.—**Melampsora larici-populina.** Fig. 7, capitate paraphysis showing thickened wall (× 1000). Fig. 8, uredospore (× 1000).

Fig. 9–12.—**Saccobolus depauperatus.** Fig. 9, details of hymenium showing immature ascospores and paraphyses (× 520). Fig. 10, single ascus (× 520). Fig. 11, operculum after ascospore release (× 520). Fig. 12, mature ascospore cluster after release showing mucilaginous capsule (× 520).

Fig. 13–14.—**Humicola stellata.**—Fig. 13, detail of conidiophore and conidium (× 1500). Fig. 14, mature conidia showing variation in shape (× 1500).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The fungus described here agrees best with Dowding's (*l.c.*) description of *G. cerealis* but differs somewhat in having larger perithecia than in the original description. This is an unimportant difference since it was noticed that the perithecia formed on diluted potato-dextrose agar were much smaller. The range of dimensions given here for the asci and spores are wider than those in the descriptions by Dowding (*l.c.*), Cain (*l.c.*) and Von Arx and Müller (*l.c.*). The dimensions given above cover those given by these authors, but do not overlap with the dimensions for the closely related species, *G. calospora* (Mouton) C. et M. Moreau which has smaller, more elongate spores than *G. cerealis*.

The dark-coloured, thick-walled sterile asci described above were seen frequently in cultures of the South African isolate. In the young state these could be distinguished by the absence of differentiated contents and early thickening and pitting of their walls while still hyaline. Later, they turn almost as dark as the spores and their numbers increase as the cultures age. Dodge (Mycologia 26: 360–376, 1934) figured similar dark-coloured indurate, sterile asci from cultures of *Neurospora tetrasperma* irradiated with X-rays. This ascus abortion was found to be due to a lethal factor which was carried over to new generations by ascospores containing two nuclei of opposite sex at their origin.

The perithecia lack true paraphyses but large, irregular thin-walled cells present among the asci, are similar to those described by Cain (*l.c.*) in ascocarps of *G. reticulospora* and *G. calospora*.

This fungus agrees with the description of *G. cerealis* which had been isolated only from the crowns of wheat and oats. Despite the difference in hosts, it appears to be identical with *Gelasinospora cerealis* Dowding.

This is a new host record for this species and the first record of the occurrence of this genus in South Africa.—G. C. A. v. d. W.

2. **Spegazzinia tessarthra** (*B. & C.*) *Saccardo* in Syll. Fung. 4: 758 (1886); Damon, Bull. Torrey Bot. Cl. 80: 162 (1953).

Figures: 5, 6.

Colony on malt agar slow-growing, up to 75 mm in diameter after 5 weeks at 25°C. Mycelium submerged, hyaline, branching, thin-walled, septate; fertile hyphae in sporodochia, simple, fuscous, ascending, elongate or reduced, bearing single, terminal conidia; sporodochia separate, scattered, up to 1 mm in diameter; conidia fuscous, four-celled, the cells arranged in the form of a Maltese cross, thin-walled, dark, smooth, $12–16 \times 6–8\mu$, or strongly echinulate, $16–24 \times 8–14\mu$, spines $2 \cdot 0–10\mu$.

Specimens examined: PRE 43723, on malt agar, isolated from *Zea mays* seed, Lichtenburg, Transvaal, June 1966; PRE 36958 on wood of *Acacia mearnsii*, Atholl Experiment Station, Natal, February 1949; PRE 10003, Fungi Malayana No. 289, on *Oryza sativa*, Mt. Maquiling, Laguna Province, Philippines.

The material described here agrees well with the description by Damon (*l.c.*). The South African isolates are closely similar to the Philippine material, determined by Saccardo (*l.c.*), in our herbarium. Of interest here is the occurrence of one South African specimen on wood of *Acacia mearnsii* which differs from Damon's (*l.c.*) statement that this fungus is common on decaying monocotyledonous plant parts.

Another species of the genus, *Spegazzinia meliolae* Zimm., is recorded by Doidge (Bothalia 5, 731, 1950) on various species of *Meliola* and related genera in South Africa.—G. C. A. v. d. W.

3. **Melampsora larici-populina** *Klebahn*, in Zeitschr. f. Pflanzen-krankh. 12: 43 (1902); Sydow, Monographia Uredinearum 3: 346 (1915); Gremmen, Tijdschr. Plziekt. 60: 245 (1954); Gäumann, Beitr. Kryptogamenfl. Schweiz 12: 132 (1959); Hennebert, Agricultura 12; 661–670 (1964).

Figures: 7, 8.

Uredosori hypophyllous, causing pale, greenish yellow spots on the upper surfaces, mostly in scattered groups over the entire lower surface, small, up to 1 mm in diameter, at first covered by the raised epidermis, later surrounded by the broken epidermis, powdery, orange-yellow to golden-yellow; uredospores oblong to oblong-obovoid, $30–42 \times 15–20\mu$, golden yellow to orange-yellow in mass, smooth at the apex but markedly echinulate-spinulose towards the base, the wall colourless, $2–3\mu$ thick but thickened equatorially to $6–9\mu$ resulting in a dumb-bell shaped lumen; paraphyses pyriform capitate $44–96\mu$ long, the upper part $15–20\mu$ in diameter with wall up to 15μ thick in the uppermost part, decreasing to $3–4\mu$ in diameter along the thin-walled stalk.

Specimens examined: PRE 43694 on *Populus deltoides*, Waterkloof, Pretoria, Transvaal, March 1967; PRE 43691 on *Populus deltoides* hybrids, Pietermaritzburg, Natal, February 1967; PRE 43692 on *Populus* sp. (Chilean poplar), Pietermaritzburg District, Natal, February 1967.

This rust species had not been seen in South Africa before but the specimens cited above were brought to the author's attention within three weeks of one another during the very wet late summer of 1967. It is the second rust species recorded on *Populus* spp. in South Africa. The other species, *Melampsora aecidioides* (D.C.) Schroet. had been recorded by Doidge (Bothalia 5: 394, 1950). *M. aecidioides* differs from M. *larici-populina* by its smaller ovoid uredospores which have their walls evenly thickened and small echinulae evenly distributed over the entire surface. Its uredosori are pale yellow in colour.

As described here, the South African collections agree well with the descriptions by Sydow (*l.c.*), Gremmen (*l.c.*), Gäumann (*l.c.*) and Hennebert (*l.c.*). The paraphyses of the South African material are larger than the dimensions given by Gäumann but agree with those of Sydow. The identity of this fungus was kindly confirmed by Dr. G. L. Hennebert of the Catholic University of Louvain, Belgium.—G. C. A. v. d. W.

4. **Saccobolus depauperatus** (*Berk. & Br.*) *Phill.* in Brit. Discom. 296 (1887); Seaver, F.J. The North American Cup Fungi (Operculates) 95 (1942).

Figures: 9, 10, 11, 12.

Apothecia scattered or gregarious, superficial, attached by short central stipe only, minute, rarely exceeding 250μ in diameter, smooth, hymenium plane or slightly convex, usually hyaline but occasionally with dilute violet pigment in the sub-hymenial layers or with a yellow pigment in the paraphyses; asci clavate with truncate apices, operculate, narrowing to slender bases, hyaline, eight-spored, $55–80 \times 15–20\mu$, interspersed with paraphyses; spores at first loosely dispersed in the apex of the ascus, finally uniting into an elongated spore mass, $30–40 \times 12 \cdot 5–14 \cdot 0\mu$; individual spores at first hyaline, darkening through deep violet to brownish violet, appearing black by reflected light, ellipsoid with narrowed ends, smooth or occasionally pitted, $12 \cdot 5–14 \cdot 0 \times 5–7 \cdot 5\mu$; paraphyses septate, slender, hyaline or occasionally coloured, reaching a diameter of $3–4\mu$.

Specimen examined: PRE 43901 (Mycological Herbarium), dried apothecia on horse dung, Onderstepoort Veterinary Research Institute, Oct. 1967.

Although the apothecia examined do not agree in every detail with the description of *S. depauperatus*, they are nevertheless considered to be representative of this species. The observed differences, viz. the absence of the lilac colour in the excipular cells, the

larger variation in size of the asci and the slightly larger ascospores and spore-clusters, are not considered to be sufficient to warrant the proposal of a new species. The variation in the colours observed is considered as expressive of strain differences and not of specific differences. The observation by Berkeley and Broome (Ann. Mag. Nat. Hist. III. 15. 1865) that the apothecia are yellowish when young, could have been due to the yellow pigment in the paraphyses being more noticeable during the stages preceeding ascospore maturity.

This species has been found on horse dung from different localities in the Transvaal and Natal and appears to be widespread.

This is the first record of the occurrence of this genus and species in South Africa. —K.T. v. W.

5. **Humicola stellata** *Bunce* in Trans. Brit. Mycol. Soc. 44: 372–376 (1961); Cooney, D. G. and R. Emerson. Thermophilic fungi. W. H. Freeman and Co. London. 80 (1964).

Figures: 13, 14.

On naturally infected grass the mycelium is hyaline, smooth-walled, regularly septate, not constricted at the septa, $1 \cdot 2$-$1 \cdot 4\mu$ in diameter; conidiophores hyaline, aseptate, smooth-walled, arising from a hyphal cell, without basal septum, $2 \cdot 0$–$9 \cdot 4 \times 1 \cdot 4$–$2 \cdot 7\mu$; conidia unicellular, hyaline, becoming dark brown at maturity, appearing black by reflected light, may be sessile on the vegetative mycelium or borne on conidiophores, spore wall thickening slightly with age, smooth, extremely variable in shape, ranging from ellipsoid to tetrahedral to cuboid to stellate, older spores usually with a prominent single refractive globule.

Specimen examined: PRE 43881 (Mycological Herbarium), colonies on dried grass hay, Johannesburg District, June 1967.

This fungus was found on bales of dried veld hay which had been exposed to rain. It was found at this locality only and is the first record of the occurrence of this genus and species in South Africa.—K. T. v. W.

6. **Chaetomium cochliodes** *Palliser* in N. A. Flora 3: 61 (1910); Ames, L. M. A monograph of the Chaetomiaceae. U.S. Army Res. and Dev. Ser. 2. 17 (1963).

On potato-malt-cellulose agar (Ames, *l.c.*) aerial mycelium is lacking. Perithecia numerous, ostiolate, subglobose, greyish green to yellow-green, attached to the substrate by dark rhizoids, seldom producing cirrhi, 300–355×265–312μ; terminal hairs numerous, of two types: (1) thick, dark brown, paling towards the tips, slightly roughened, with few terminal convolutions; (2) thin, olivaceous or lighter, undulate or coiled; lateral hairs numerous, dark brown, paling towards the tips, straight, slightly roughened; asci deliquescing before spore maturity, clavate, hyaline, eight-spored, 80–95×9–12μ; ascospores hyaline when immature, darkening to olive brown at maturity, irregularly biseriate, ellipsoid, bi-apiculate, $8 \cdot 0$–$9 \cdot 5 \times 6$–8μ.

Specimen examined: PRE 42931 (Mycological Herbarium), dried culture, isolated from garden soil, Pietermaritzburg, Natal, Sept. 1962.

This is the first record of the occurrence of this species in South Africa.—K. T. v. W.

Bothalia 10, 1: 89–120

An Ordination of the Vegetation of Ntshongweni, Natal*

by

J. W. Morris

Abstract

The physiography, soils, climate and dense woody vegetation are briefly described for Ntshongweni, a cone-shaped hill in Natal, South Africa (29° 51′ S and 30° 43′ E). A primary ordination of the woody plants, based on Bray & Curtis's (1957) method, was carried out using 60 quadrats. Four stand noda were delimited and another four noda within a secondary ordination of a cluster of quadrats which could not be interpreted within the primary ordination. Edaphic and atmospheric moisture conditions and slope aspect were proposed as the main site factors correlated with species performance. Tables of density, local frequency and constancy for species occurring in each nodum were drawn up.

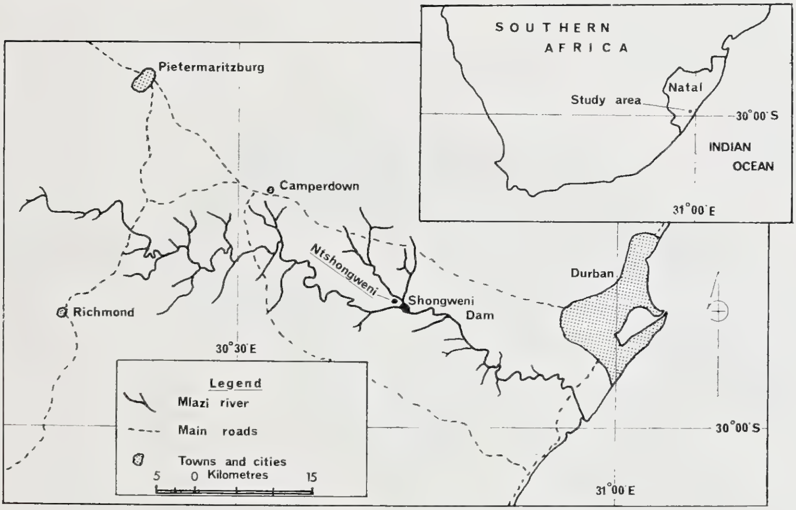


Fig. 1.—Location of Ntshongweni, the study area.

Introduction

Ntshongweni is the name of a steep-sided, cone-shaped hill situated in the Mlazi River Valley, Natal at the intersection of co-ordinates 29° 51′ S and 30° 43′ E (Fig. 1). The anglicized name of the hill is given to Shongweni Dam, completed in December, 1927, at the foot of the hill. Since construction, the dam and land in the vicinity, including Ntshongweni, have been controlled by the Durban Municipality.

*From a thesis accepted for the degree of M.Sc. by the Department of Botany, University of Natal, Pietermaritzburg.

Gleason (1926) and Ramensky (cited in Whittaker, 1962), working independently at about the same time, first proposed the Individualistic Hypothesis of vegetation structure. The Hypothesis holds that no two communities are strictly identical in floristic composition. Instead, communities exhibit continuous variation in detailed composition and cannot be readily delimited as clearcut units. No discontinuities in compositional variation occur, except where there are discontinuities in the physical environment. Ordination studies by many ecologists, including Curtis & McIntosh (1951), Whittaker (1956 and 1960), Bray & Curtis (1957) and Curtis (1959), have shown that variation in composition is continuous, except where the environment is discontinuous, and have thus fostered the Individualistic Hypothesis. On the hill, Ntshongweni, there is a gradual change in slope aspect from north-west through north, east and south to south-west and an altitude gradient of over 200 m. It was considered that the effect of aspect and altitude on the vegetation of the hill was eminently suitable for study by ordination and that the vegetation was likely to conform to a continuum in the manner indicated by the Individualistic Hypothesis.

Ordination, the technique used in this account, is the uni- or multi-dimensional arrangement of stands so that a statement of stand position, relative to other stands or to the axis or axes of the model, conveys the maximum amount of information about its composition. It is thus an ecological tool for summarizing and ordering information about the distribution and relative abundance of plants. Rewarding use can be made of

Plate 1.—View of Ntshongweni from the north-west.

ordination as a framework for indicating potential environmental correlations because the complexity of environmental factors determining plant distribution may be better measured indirectly, through studying the plants, than by direct measurement of the environment.

Physiography and Soils

The hill, Ntshongweni, is bounded on its north and south sides by the deep valleys of the Sterkspruit and Mlazi Rivers. From the surface of Shongweni Dam at an altitude of about 300 m, the land rises, gently at first, and then steeply, to high sandstone cliffs that almost surround a small summit plateau at over 500 m above sea level (Fig. 2). The cliffs are composed of a band of fine-grained rock, the Orthoquartzitic Marker Band of the Table Mountain Series (Rhodes & Leith, 1966). The Marker Band is underlain by the sandstones, grits and shales of the Basal Zone of the Table Mountain Series that rests unconformably on Basement Complex Granite (Dodson, 1951). The narrow valley floors are of sandy alluvium.

The soils of the summit plateau and area east of the eastern fault (Fig. 2) are deep, grey- or red-brown, coarse, sandy loams with low organic-matter content. On the steep north- and south-facing slopes of Ntshongweni the soil is a shallow, greyish-brown, gritty loam. Large and small sandstone talus boulders add heterogeneity to the granite-derived soils. The influence of talus is most apparent immediately beneath the Marker Band cliffs.

Climate

Insolation and temperature

On account of the steep topography, the south-facing slopes of Ntshongweni are often in shadow and only intercept direct insolation in the early morning and late afternoon. West-facing slopes, receiving insolation in the afternoon, become hotter than east-facing slopes, because ambient temperatures are higher in the early afternoon than in the morning. Thus the north- and north-west-facing slopes, which receive most direct sunlight every day, become hotter and have a higher rate of evaporation than south-facing slopes. It was assumed that a gradient of insolation and temperature from high to low existed from the north-facing slopes to the south-facing slopes.

During the 25 year period when temperatures were recorded (Table 1), the absolute maximum was 43·9°C at the dam on the valley floor. During the same period, the absolute minimum temperature was 2·8°C. The difference in mean monthly temperature between summer and winter was less than 10°C. Frost was not observed by the writer at Shongweni Dam and is apparently rare.

Table 1.—Temperature data for Shongweni Dam Weathei Station, 1932 to 1946, from Weather Bureau (1954a)

	Mean monthly	Absolute maximum	Absolute minimum
January	22·5	40·6	7·2
February	22·6	38·9	11·1
March	22·3	39·4	11·1
April	20·8	36·7	8·3
May	18·4	35·6	5·0
June	16·0	33·9	4·4
July	15·5	32·8	2·8
August	16·5	36·7	3·9
September	18·2	40·0	6·1
October	19·7	41·7	8·3
November	21·2	41·7	7·2
December	22·0	43·9	9·4

Rain and fog

Nearly all geographers, according to Jackson (1952), and many ecologists have in the past explained wind direction and South Africa's summer rainfall in terms of a low pressure trough over the interior during summer and an anticyclonic circulation over the interior during winter. Jackson has shown, however, that this explanation is not consistent with known wind directions. During summer and winter an anticyclone is centred over the eastern Transvaal so that the normal air circulations are similar in summer and winter and the seasonal reversal of prevailing wind direction, as suggested previously, is not possible. The two prevailing winds at Shongweni Dam are north-east and south-west in approximately equal proportions throughout the year (Schulze, 1965). North-east winds blow during fair weather and south-west winds accompany cold fronts and rain.

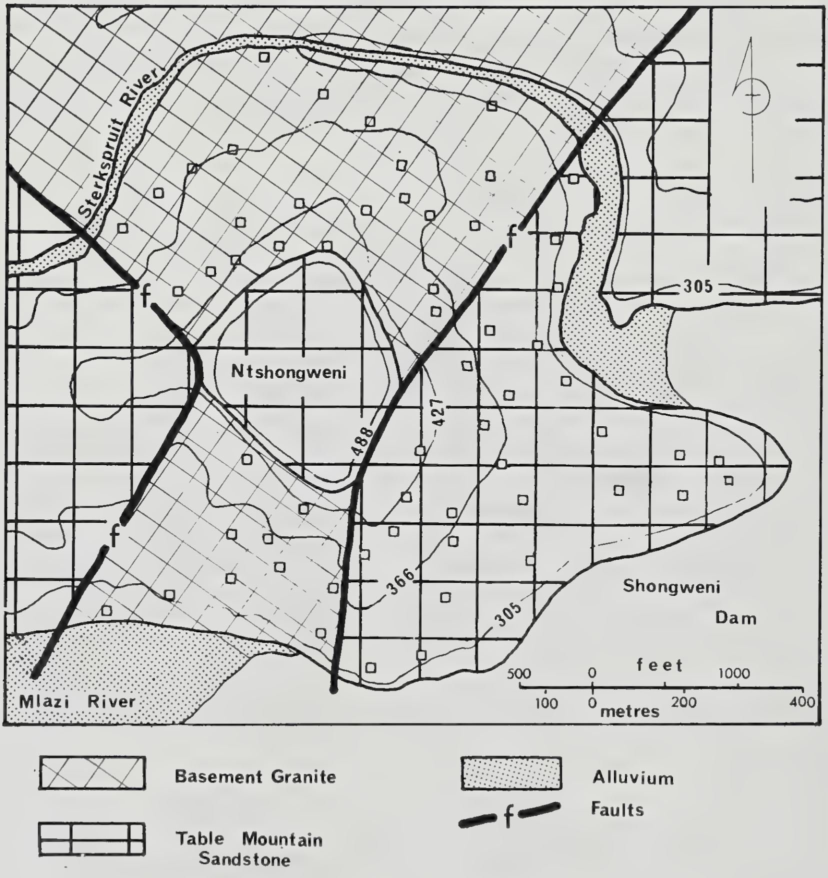


FIG. 2.—Geological map of Ntshongweni (partly after Dodson, 1951).

Accounts of the synoptic situations associated with frontal activity and thunderstorms in Natal are described by Tyson (1964a and b and 1965). Rain is brought by cold fronts which sweep along the east coast of South Africa throughout the year at two- to three-weekly intervals. Precipitation from these fronts is mainly confined to the summer months. Cold fronts are preceeded by hot, dry, gusty, north-west Berg Winds which blow for one to three days at a time. In summer, following the passage of a cold front, the wind becomes south-westerly, the temperature drops rapidly, a thick cloud cover builds up and gentle, continuous rain may be expected. In winter, a temperature drop follows a cold front and a cloud layer may develop but rain is unusual. Rain is also brought by summer storms of high intensity and short duration, during which 25 mm of rain, or more, may fall in two hours.

The rainy season at Shongweni Dam, during which 80 per cent of the mean annual precipitation may fall, extends from October to April. Mean annual rainfall for the period 1929 to 1950 was 773 mm (Weather Bureau, 1954b). The highest recorded rainfall of 1165 mm occurred in 1943, and the lowest of 519 mm in 1949.

In summer, fog may cover the higher slopes of Ntshongweni for two or three days at a time following the passage of a cold front. Exact frequencies of fog are not known but it was observed about four times per month during the summer of 1966. During the dry season, radiation fogs may form. These fogs were seen on only two occasions at Shongweni Dam during 1966. Radiation fogs are associated with the formation of inversions in valleys at night and are dispersed by the sun's warmth each morning.

Vegetation

General description of vegetation

History

The vegetation of the study area was subjected to intense disturbance prior to the building of Shongweni Dam and the declaration of the catchment immediately above the dam as a Nature Reserve in about 1920. Comparison of the aerial photograph taken in 1937 (Plate 2: 1) with that taken in 1959 (Plate 2: 2) shows the change in cover which took place over 22 years in the absence of tree felling and cultivation by Bantu. Large portions of the peninsula surrounding the Bantu Kraal and areas south-east of the summit of Ntshongweni which lacked trees in 1937 had, by 1959, a good tree cover. Throughout the area, the cover of trees increased, the summit of Ntshongweni showing least increase although individual bush clumps appear bigger in the later photograph.

Major vegetation types

The edges of the flat summit of Ntshongweni and of the surrounding tableland form a sharp boundary between the physiognomically and floristically different plateau and valley vegetation types. Differences are a possible result of two major environmental factors. Firstly, the poorly drained, more-or-less level plateau differs with regard to soil moisture status from the steep, well-drained valley slopes. Secondly, the presence of summer fog on the upper slopes and plateau makes this environment moister than that of the lower valley slopes. The sandy soils of the plateau are underlain by the water-impermeable Orthoquartzitic Marker Band. Evidence for the presence of the Marker near the soil surface is given locally by the occurrence of *Syzygium cordatum*, a tree usually found along streams, but able to grow on the plateau where drainage is impeded and the water table is high.

Only the valley vegetation was analysed quantitatively. A brief description of the vegetation of the plateau and valley is given below, prior to an account of the quantitative study.

PLATE 2.—1, Aerial photograph of Ntshongweni taken in 1937; 2, same, 1959. Photos: Trigonometrical Survey Office.

1. *Plateau vegetation*

(*a*) Aristida junciformis *Grassland*

A grassland of perennial, tufted grasses up to 1 m high in autumn, is the principal plateau community. *Aristida junciformis*, which is unpalatable to cattle except in the early part of the growing season, is dominant in terms of cover. Other grasses include *Andropogon amplectens*, *Cymbopogon validus*, *Eragrostis capensis*, *E. chapelieri*, *E. plana*, *Panicum natalense* and *Trichoneura grandiglumis*. Spring aspect forbs are *Cassia plumosa*, *Eriosema salignum*, *Hypoxis* sp., *Pentanisia angustifolia*, *Polygala hotentotta*, *Rhynchosia totta*, *Tephrosia macropoda* and *Wahlenbergia undulata*. In autumn, tall, half-woody dicotyledons, such as *Pseudarthria hookeri* and *Leonotis dysophylla*, are prominent.

(*b*) Faurea saligna *Woodland*

The narrow-crowned tree, *Faurea saligna*, usually occurs on shallow, sandy soils in almost pure stands. Individuals are up to 4·5 m high with 2–6 m between crowns. Occasionally, *Acacia nilotica* and *Albizia adianthifolia* also occur. Many *F. saligna* trees, cut off about 20 cm above ground level, have produced a multiple-stemmed coppice. As *F. saligna* is prized as firewood by Bantu (pers. comm. Professor A. W. Bayer), it was probably felled for this purpose.

(*c*) Combretum molle-Acacia nilotica *Woodland*

Where the soil is deeper, a number of tree species form an open, deciduous, *Combretum molle-Acacia nilotica* Woodland. Distance between the flat, spreading crowns of the trees, which are up to 4·5 m high, varies from 1 m to about 6 m. *Combretum molle* and *Acacia nilotica* are dominant, but *A. robusta*, *Albizia adianthifolia*, *Syzygium cordatum*, *Apodytes dimidiata*, *Euphorbia ingens* and *Tarchonanthus trilobus* are also frequent. Shorter trees, growing to 3·5 m, include *Acacia gerrardii*, *Sapium integ rrimum*, *Maytenus heterophylla*, *Dichrostachys cinerea* and *Vangueria infausta*. Two herbaceous climbers of this community are *Clematis oweniae* and *Riocreuxia torulosa*. *Aristida junciformis* forms a continuous understory between the trees.

2. *Valley vegetation*

(*a*) *Rocky Hillside Scrub*

A scrub vegetation is found on the very steep, talus-littered slopes immediately beneath the cliffs which crown Ntshongweni. On the north-facing slopes, in the immediate vicinity of the sandstone cliffs, *Crassula portulacea*, *Tarchonanthus trilobus*, *Canthium ciliatum*, *Aloe arborescens* and *Urera tenax* are common. Where the soil is a little deeper, trees 4–5 m high from an open, uneven canopy. Trees on the north-facing slopes include *Euphorbia tirucalli* and *Combretum molle* as dominants, with *Brachylaena elliptica*, *Euphorbia ingens Hippobromus pauciflorus*, *Spirostachys africana*, *Commiphora harveyi*, *Dombeya rotundifolia* and *Grewia occidentalis* also occurring. The succulents, *Euphorbia ingens*, *E. tirucalli*, *Crassula portulacea* and *Aloe arborescens*, are a feature of this community. As rainfall runoff is high, the presence of these more drought-tolerant succulent species is possibly a response to the relatively dry edaphic conditions.

On the south-facing slopes, *Aloe arborescens* and *Euphorbia grandidens* are common between rocks. Both are up to 1·5 m high. *Pavetta gracilifolia*, which is rarely over 30 cm high and is heavily browsed, is a common shrub of this community. *Iboza riparia*, *Sansevieria thyrsiflora* and *Senecio fulgens* are undergrowth herbs. An interesting herbaceous climber in an early stage of the woody plant succession on the south-facing slopes is the fern *Microgramma owariensis*, which appears to be restricted in distribution to this community. *Petopentia natalensis* is another common, herbaceous climber.

(*b*) Aloe-Dombeya *Woodland*

One of the most easily-distinguished communities of the study area is *Aloe-Dombeya* Woodland, found on the steep, lower, north-facing slopes of Ntshongweni on mineral soils derived from deeply weathered granite. The most conspicuous component of the community is *Aloe candelabrum* which grows to 2 m high and has large, succulent leaves. Other woody plants of the community are 2·5–4 m high and form an open woodland with a grass understory 60 cm high. Important species are *Dombeya rotundifolia*, *Combretum molle*, *Dichrostachys cinerea*, *Euphorbia tirucalli*, *Brachylaena elliptica* and *Cussonia spicata*. The largest tree clumps contain, in addition, *Spirostachys africana*, *Commiphora harveyi*, *Grewia occidentalis*, *Canthium locuples*, *Acacia gerrardii* and *Dalbergia obovata*. Common grasses of the field layer are *Sporobolus pyramidalis* and *Eragrostis curvula*, while *Tagetes minuta* and *Bidens pilosa* are common weeds. The presence of these four last-mentioned species indicates a previous history of disturbance.

Plate 3.—**Aloe-Dombeya** Woodland.

(*c*) Acacia nilotica-A. karroo *Woodland*

The valley slopes east of Ntshongweni are occupied by *Acacia* spp. Woodland. The aspects are north-east-, east- and south-east-facing, but varying angle of slope and earlier interference by man throughout the area have produced a mosaic of plant communities. Soils, usually derived from Table Mountain Sandstone, are deep, except on steep slopes. The trees are usually 2–4 m high, but can be 6 m high occasionally. Many

are deciduous and have widespreading crowns. Trees which reach the open or closed canopy in *Acacia* spp. Woodland include *Acacia nilotica, A. karroo, A.gerrardii, Dichrostachys cinerea, Grewia occidentalis, Acacia robusta, Clerodendrum glabrum, Combretum molle, Acacia caffra, Rhus chirindensis, Sclerocarya caffra, Strychnos decussata* and *Ozoroa paniculosa.* Shorter trees and shrubs include *Xeromphis rudis, Brachylaena elliptica* and *Sapium integerrimum.* On the mesic, south-east-facing slopes *Dombeya rotundifolia, Hippobromus pauciflorus, Maytenus heterophylla, Heteropyxis natalensis, Dombeya tiliacea, Protorhus longifolia* and *Erythrina lysistemon* are found in addition to the trees mentioned previously.

On parts of the south-east-facing slopes occur almost pure stands of *Heteropyxis natalensis,* a short tree 2 m high, together with a few *Acacia caffra* trees. This woodland may have resulted from the invasion of old fields on the south-east-facing slopes by *H. natalensis* and *A. caffra.*

(*d*) Euphorbia tirucalli *Succulent Scrub*

A small, dense stand of *Euphorbia tirucalli* on the peninsula which juts out from Ntshongweni into the dam now grows on the site of what was at one time a Bantu Kraal. The site of the abandoned kraal can be seen in the aerial photograph taken in 1937 (Plate 2: 1) and is still visible, as a ring of dark vegetation, in the 1959 photograph (Plate 2: 2). In this area, *Euphorbia tirucalli* trees are usually single-stemmed, about 6 m high, and average 1 m between boles. *Acacia nilotica* is found occasionally beneath the canopy as a straggly tree 3–4 m high and *Dalbergia armata* occurs as a woody climber. A few scattered herbs of Acanthaceae, including *Hypoestes aristata* and *Phaulopsis imbricata,* occur where the shade is not too dense. In view of the spread of *E. tirucalli* on the north-facing slopes of Ntshongweni and its dominance on the old Kraal site, the absence of *E. tirucalli* from the *Acacia* spp. Woodland is remarkable. *E. tirucalli* was probably planted at the Kraal as a hedge, a practice of the Bantu in the area to this day.

(*e*) Spirostachys africana *Woodland*

On the hot, dry, north-west-facing slopes of Ntshongweni *Spirostachys africana* Woodland occurs. These slopes are made up from a number of small gulleys separated by ridges. The ridges have drier soils as a result of higher runoff and better drainage than the gulleys, where both surface and subterranean water concentrates.

Spirostachys africana, with a thick, black, rough bark, and a diameter at breast height of up to 30 cm, is the dominant tree. Associated trees on the ridges are *Euphorbia ingens, E. tirucalli, Hippobromus pauciflorus, Combretum molle, Grewia occidentalis* and *Ptaeroxylon obliquum.* Commonly occurring small trees and shrubs, which form a discontinuous, short tree and shrub layer up to 3 m high, include *Brachylaena elliptica, Ehretia rigida* and *Tricalysia lanceolata.* Where the canopy is broken, *Aloe candelabrum* occurs. Components of the dense ground flora include *Achyranthes aspera, Sansevieria thyrsiflora, Hypoestes aristata, Hibiscus pedunculatus* and *Panicum deustum.*

The canopy is denser, there are fewer deciduous components, and the shade cast is much deeper in the gulleys than on the ridges. *Spirostachys africana* and *Acalypha sonderiana* are co-dominant in gulleys and other common components include *Combretum molle, Commiphora harveyi, Euclea natalensis* and *Euphorbia tirucalli.* The shade in summer would appear too dense for the development of a dense ground flora as the ground is usually almost bare.

(*f*) Hippobromus-Acalypha *Woodland*

This occurs on the south-facing slopes of Ntshongweni where insolation is lower and, as a result, temperatures and evaporation rates are lower than elsewhere in the study area. Soils are derived from granite with varying degrees of admixture from the sandstone above. Under the sandstone cliffs, slopes are steep and soils shallow, but at

lower altitudes soils become deeper and slopes more gentle. The south-facing slopes, like the north-west-facing slopes, are made up of edaphically drier ridges with greater runoff and subsurface drainage than the intervening gulleys.

Canopy trees found on the ridges include *Hippobromus pauciflorus*, *Ziziphus mucronata*, *Heteropyxis natalensis*, *Dombeya rotundifolia*, *Rhus chirindensis*, *Euphorbia ingens*, *Grewia occidentalis*, *Combretum molle*, *Protorhus longifolia* and *Xylotheca natalensis*. A discontinuous layer of dark-green leaved shrubs, up to 2 m tall, includes *Euclea natalensis*, *Azima tetracantha* and *Maytenus undata* below the canopy. A 60 cm high, lush, ground flora of grasses and dicotyledonous herbs, includes *Panicum deustum* and *Sansevieria thyrsiflora*.

In the gulleys dense shade is cast by the thick, closed canopy of dark green leaves. Common trees include *Acalypha sonderiana*, *Dombeya tiliacea*, *Grewia occidentalis*, *Baphia racemosa* and *Euclea natalensis*. A large number of other species contribute occasionally to the canopy stratum. *Tricalysia lanceolata* and *Dovyalis rhamnoides* are common shrubs, while *Popowia caffra* occurs frequently as both a shrub and a climber. Common components of the herb layer are *Achyranthes aspera*, *Argyrolobium tomentosum*, *Crocosmia aurea*, *Cyathula cylindrica*, *Hypoestes aristata*, *Oplismenus hirtellus*, *Panicum deustum*, *Phaulopsis imbricata*, *Plectranthus purpuratus*, *Priva cordifolia* and *Sansevieria thyrsiflora*.

On the boundary between gulley and ridge, a dense, impenetrable tangle of woody lianes often develops. The lianes, including *Dalbergia obovata*, *D. armata*, *Scutia myrtina*, *Acacia ataxacantha* and *Capparis tomentosa* with stems up to 7 cm in diameter, form a dense tangled growth from ground level to a height of about 4 m. Emergent trees 4·5–6 m high, including *Grewia occidentalis*, *Clerodendrum glabrum* and *Dombeya rotundifolia*, occur occasionally. *Erythroxylum emarginatum* and *Popowia caffra* are evergreen shrubs or scramblers up to 2 m high that occur in the tangle. The ground flora is poor.

Quantitative analysis of valley vegetation

Methods

1. *Sampling*

The valley vegetation on the sides of Ntshongweni and on the peninsula which juts into Shongweni Dam were sampled for the quantitative study. Density values for trees over 1 m high were recorded from 60 square sample areas, which are termed stands, of side 30·5 m ($\frac{1}{4}$ acre). Stands were located by restricted randomisation, with the advantage of sampling the area efficiently and allowing statistically-valid comparisons of the samples to be made. Aspect, angle of slope, rock type and soil depth were the site factors recorded for each stand.

Species-area curves were plotted (Fig. 3) to determine a satisfactory sample size. The smallest size used was 2·3 sq m (25 sq ft) and increasing sizes were obtained by doubling the area to a maximum of 595·4 sq m (6,400 sq ft). The method is unsatisfactory according to Greig-Smith (1964) as the different sizes are not independent and, therefore, the number of species may be exaggerated. A more satisfactory method is the use of separate, randomly placed samples of each size (Greig-Smith, 1964). The latter method was not used at Ntshongweni, however, because the scale of pattern is such that samples located at random would almost certainly land in more than one community and thus overestimate the number of species per community. Although a marked change in the rate of increase of species number with increasing sample size occurs at the 74·4 sq m (800 sq ft) size the number of species continues to increase appreciably to the maximum

sample area. It was thus decided to use samples larger than 595·4 sq m. The minimal area would not be reached before the sample was either too large for a density count to be made in a reasonable time, or more than one community would be included in the sample as a result of the pattern of gulleys and ridges. The 595·4 sq m sample size was eventually chosen, therefore, as being the largest stand consistent with the scale of pattern of the vegetation and that could be analysed within a reasonable amount of time.

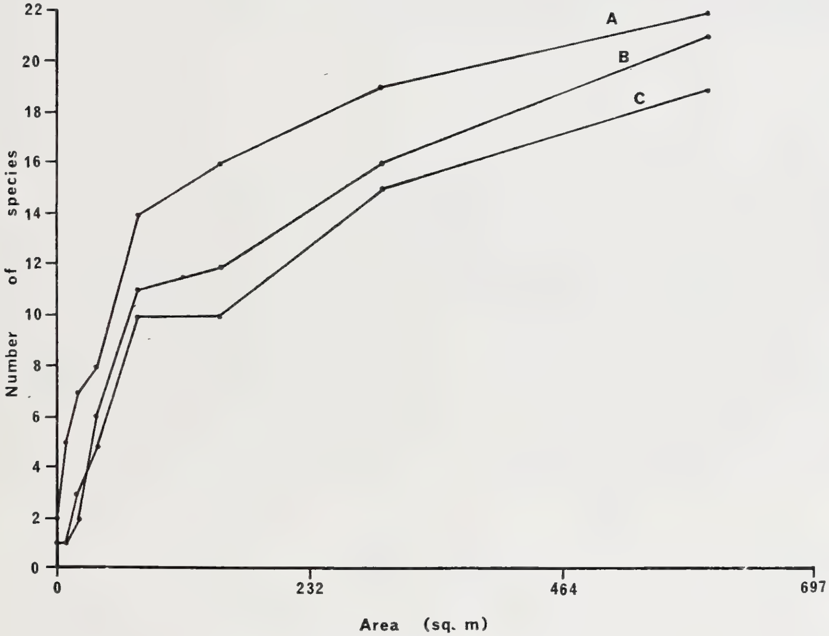


FIG. 3.—Species-area curves for three localities.

The square stands were divided into four strips [30·5 m by 7·6 m (100 ft by 25 ft)] and each strip into four squares of side 7·6 m (25 ft) for ease of sampling, so that local frequency data were available from the 16 sub-samples comprising each stand, and so that samples with areas from 7·6 m^2 to 30·5 m^2 were available for analysis.

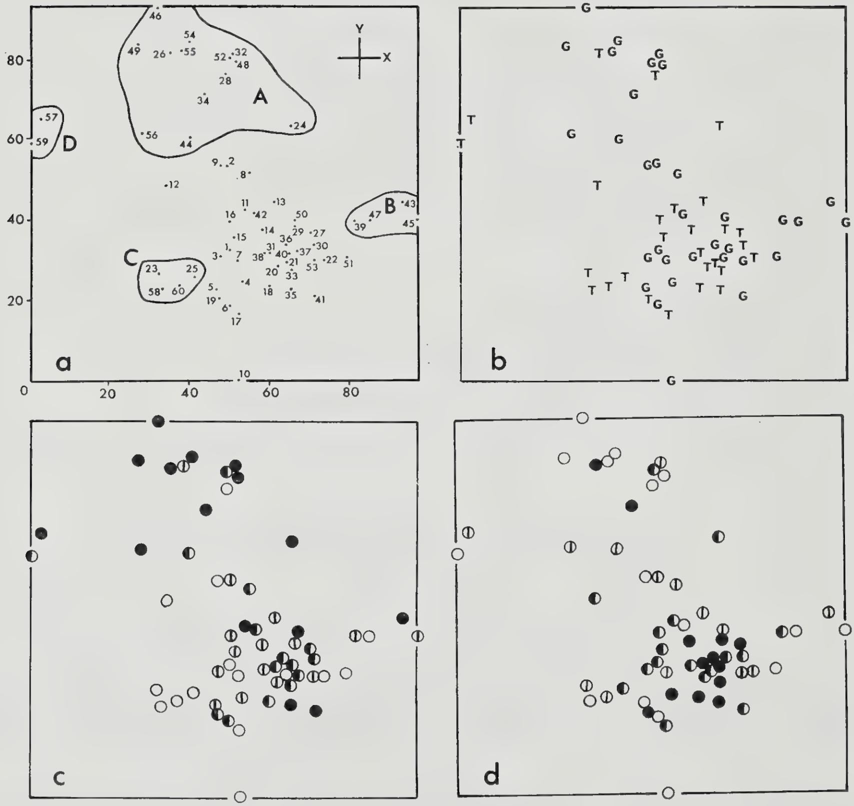
2. *Ordination*

The ordination was based on that developed by Bray & Curtis (1957) and described in detail by Beals (1960). Initially, coefficients of similarity (C) between every possible pair of stands were calculated. Expressed as a percentage for two stands, M and N, the coefficient is given by:

$$C_{(MN)} = \frac{2w}{a+b} \times 100$$

where a is the sum of the density values of all species in stand M, b is the sum of the values in stand N, and w is the sum of the lower values recorded for species common to stands M and N. The coefficient may have a value of 100 if the stands are identical in species composition and density, a value of zero if the stands have no species in common or an intermediate value dependent upon the degree of similarity of the stands.

The number of similarity coefficients in the matrix of 60 stands sampled at Shongweni Dam was 1770. Two hundred and eighty of these coefficients had values under 10 per cent, 756 under 20 per cent, and 1153 under 30 per cent. Applying Beals's criteria of end stand selection to these very low similarity coefficients resulted in tight clustering of stands in the centres of the first and second axes. Inspection of the coefficients of similarity between pairs of stands situated in the tight clusters showed that many were very dissimilar from each other and should not have been placed as close together as they were. The level of distortion was thus high and the axes inefficiently utilized.



Key to all figures showing quartile distributions within ordinations.
absent: —   1st quartile: ○
2nd quartile: ◑   3rd quartile: ◐
4th quartile: ●

FIG. 4.—a, Primary ordination where numbers enclosed by solid lines refer to stands mapped in Fig. 5 Axes are in percentage dissimilarity. A = **Acalypha sonderiana** Nodum; B = **Aloe candelabrum** Nodum; C = **Euphorbia ingens** Nodum: and D = **Euphorbia tirucalli** Nodum: b, distribution of Table Mountain Sandstone (T) and Basement Complex Granite (G) within the ordination; c, quartile distributions of total density per stand within the ordination; d, quartile distributions of number of species per stand within the ordination.

The problem was not overcome by using three dimensions. These considerations lead to the modification of Beals's criteria for end stand selection as described below (see also Morris, 1967).

The sum of the similarities of each stand with every other one was found and the standard deviation of each mean similarity calculated. Stands with low sums of similarity but high standard deviations were chosen for end stands. Choosing stands with low sums of similarity ensured that the axis was relatively long while a high standard deviation meant that the stands were spread along the axis and not clustered in one section of the axis.

Results

1. *Primary ordination*

(*a*) *Assessment for noda*

Four groups of stands with similar floristic composition, termed noda, and named after the species with the highest mean density in the stands making up the group, are delimited within the primary ordination, shown in Fig. 4a and mapped in Fig. 5. The stands clustered in the centre of the ordination, between the delimited noda, are later shown to be heterogeneous and to form more than one nodum. A clear discontinuity exists between the stands of the *Euphorbia tirucalli* Nodum and all other stands (Fig. 4a). The other three noda grade into the central cluster and their delimitation was done after considering the positions of the stands, in the field and within the ordination, and of species distributions within the ordination. Other, equally justifiable delimitations are possible. The justification for the delimitation of the *Euphorbia ingens* Nodum, which appears inseparable from the stands of the central cluster, is given later. It is described in this section because of its close proximity in the field to the *Euphorbia tirucalli* Nodum. Noda are delimited to aid discussion and do not indicate that the Individualistic Hypothesis does not hold.

(*b*) *Relationships of noda to site factors*

Stands of the *Acalypha sonderiana* Nodum are located on the upper slopes of Ntshongweni facing north-west, north and east (Fig. 5). On the north-west-facing slope the Nodum extends down from the cliff surrounding Ntshongweni, and on the east-facing slope a tongue, terminated by stands 24 and 26, extends down from the cliff towards the Sterkspruit River. Investigations in the field and of the aerial photographs showed that these tongues follow gulley courses. From Fig. 4b, most stands of the community are seen to occur on Basement Granite. Most stands are located under the Table Mountain Sandstone cliffs on very steep slopes with shallow soils.

The four stands making up the *Aloe candelabrum* Nodum are found along the Sterkspruit River on the lower north-facing slopes of the hill. The shallow soils are derived from Granite (Fig. 4b). The convex ground form, in contrast to the concave form where stands of the *Acalypha sonderiana* Nodum are found at this altitude, suggests less favourable soil moisture conditions in the *Aloe candelabrum* Nodum.

The *Euphorbia ingens* Nodum is located on the peninsula which extends into Shongweni Dam, east of Ntshongweni, where the deep sandy soils are derived from Table Mountain Sandstone (Fig. 4b). The central portion of the peninsula, on which all four stands are located, is level.

Two stands, constituting the *Euphorbia tirucalli* Nodum, were found on the site of the old Bantu Kraal. Being so far removed within the ordination from all others, these stands have floristic compositions which are very different from all the other stands. Overall site conditions appear no different from stands of the surrounding area occupied by the *Euphorbia ingens* Nodum.

(*c*) *Species behaviour*

Instead of actual density values, quartile values are plotted within the ordination as species behaviour is then easier to comprehend. The total number of non-zero density values, arranged in order of magnitude, is divided into four groups (quartiles) containing, as near as possible, equal numbers of stands.

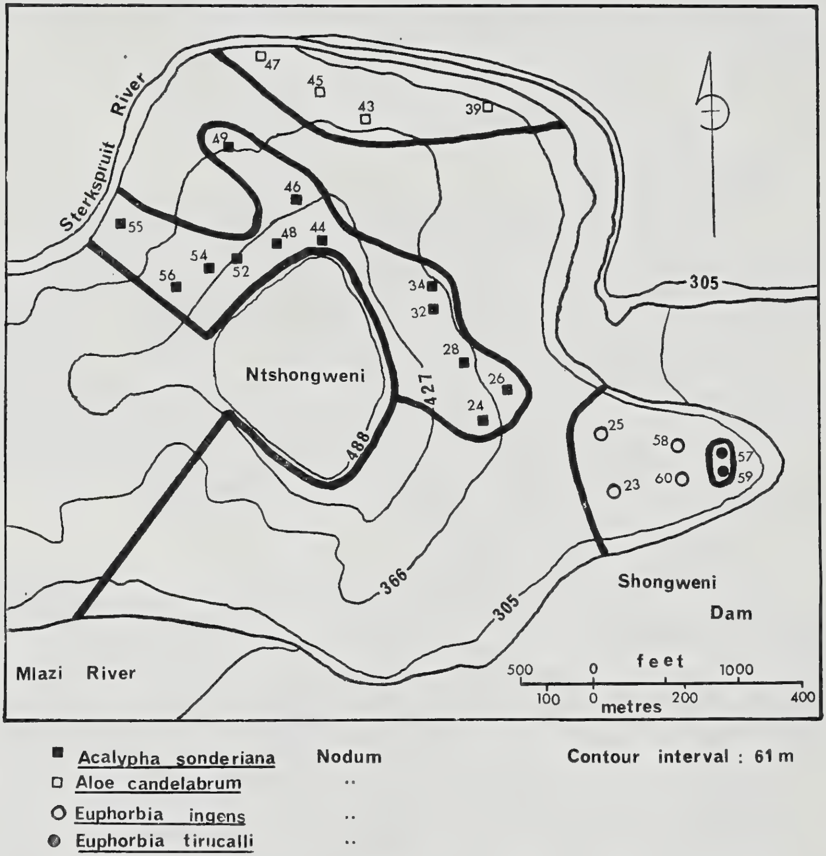


Fig. 5.—Map of Ntshongweni showing noda delimited in the primary ordination For clarity, stands delimited in the secondary ordination are omitted.

With few exceptions, high total densities (Fig. 4c) are found in the *Acalypha sonderiana* Nodum and in the *Euphorbia tirucalli* Nodum, whereas low total densities are found in the *Aloe candelabrum* Nodum and in the *Euphorbia ingens* Nodum. Stands of the central cluster have both high and low total densities. All four noda are notable for the low number of species per stand (Fig. 4d), while most stands of the central cluster have many species per stand. Stands of the *Acalypha sonderiana* and *Euphorbia tirucalli* Noda thus have high densities of a few species while the stands of the *Aloe candelabrum* and *Euphorbia ingens* Noda have low densities of few species.

Only selected species are plotted within the primary and secondary ordinations. Some unplotted species appear scattered at random within the ordinations while some show, less clearly, the patterns shown by species which are plotted.

Stands containing high densities of *Acalypha sonderiana* (Fig. 6a) are almost entirely restricted to the *Acalypha sonderiana* Nodum, while *E. tirucalli* (Fig. 6b) occurs in stands of the *Euphorbia tirucalli* and *Acalypha sonderiana* Noda but not in the *Euphorbia ingens* Nodum, which occupies the rest of the peninsula. Mean densities, mean local frequencies and constancy for species occurring in stands of the *Acalypha sonderiana* Nodum are given in Table 2. Mean density is per stand of 930·25 sq m ($\frac{1}{4}$ acre) and local frequency is derived from the 16 sub-samples of which each stand consists. An idea of the variability about the mean values may be obtained from the standard deviations of each mean, given also in Table 2. Constancy is the frequency of occurrence of the species in the stands of the nodum, expressed as a percentage of the total number of stands in the nodum. The floristic composition of an " average " stand within the area occupied by the nodum is given by the table. The high densities of *A. sonderiana* and *E. tirucalli* in the *Acalypha sonderiana* Nodum suggest that site conditions are very suitable for their growth.

TABLE 2.—Mean density and mean local frequency, with standard deviations (s.d.), and constancy for species occurring in more than two of the 13 stands of the *Acalypha sonderiana* Nodum with a mean density greater than unity

Species	Density		Frequency		Constancy
	mean	s.d.	mean	s.d.	
*Acalypha sonderiana	151·6	87·2	12·8	5·3	92·3
*Euphorbia tirucalli	75·4	60·8	11·8	5·0	100·0
Spirostachys africana	25·4	18·4	10·3	6·0	84·6
Hippobromus pauciflorus	15·5	25·3	3·8	4·3	84·6
*Combretum molle	15·3	15·7	7·5	5·6	92·3
Grewia occidentalis	9·1	9·4	5·2	3·6	92·3
Canthium mundianum	8·5	20·6	2·5	3·6	69·2
Dombeya tiliacea	8·5	7·2	5·1	4·2	84·6
*Brachylaena elliptica	7·9	7·7	5·0	3·5	92·3
Ehretia rigida	5·9	4·9	4·5	3·4	84·6
Urera tenax	5·3	12·9	2·4	6·4	46·2
Euclea natalensis	4·7	4·2	3·8	3·4	84·6
Xeromphis rudis	4·0	4·6	2·9	3·2	69·2
Commiphora harveyi	3·8	2·2	2·8	2·0	100·0
Euphorbia ingens	2·7	2·7	2·2	2·3	76·9
Schrebera alata	1·9	3·9	1·5	3·1	46·2
Putterlickia verrucosa	1·8	3·1	1·5	2·6	38·5
*Aloe candelabrum	1·7	2·9	0·9	1·5	46·2
Ochna arborea	1·7	2·1	1·5	1·5	84·6
Cussonia spicata	1·4	1·5	1·2	1·2	61·5
Acacia robusta	1·2	1·5	1·0	1·4	61·5
Erythroxylum emarginatum	1·1	2·3	0·9	1·8	38·5
Total of 30 other species	14·7				
Total mean density	369·0				

* Plotted within the primary ordination

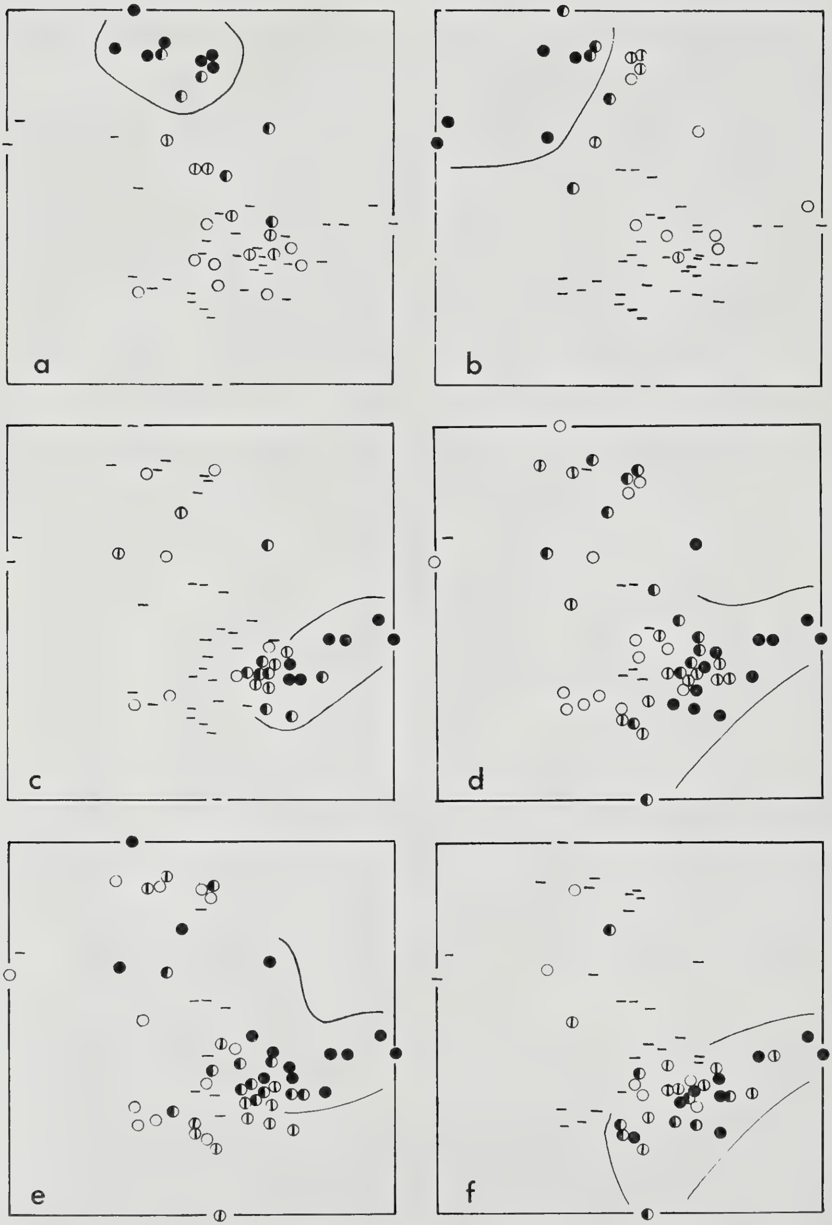


FIG. 6.—Quartile distributions of a, **Acalypha sonderiana**; b, **Euphorbia tirucalli**; c, **Aloe candelabrum**; d, **Brachylaena elliptica**; e, **Combretum molle**; f, **Dombeya rotundifolia** densities within the primary ordination. See Fig. 4 for key to symbols.

Stands on the upper slopes of Ntshongweni are shown by the ordination to be similar to stands in gulleys near the valley bottom. The floristic similarity between these altitudinally-distinct localities can possibly be explained by the compensatory effect of soil moisture and "atmospheric" moisture regimes. Run-off is rapid and drainage good on the steep upper slopes while gentler slopes and thus better moisture retaining capacities are found at lower altitudes. This gradient from dry to moist is compensated for by an atmospheric moisture gradient from moist to dry. The air is often moister and precipitation possibly higher on the upper slopes, through the presence of fog, than at the base of the hill.

Species which have distributions centred on stands of the *Aloe candelabrum* Nodum include *Aloe candelabrum*, *Brachylaena elliptica*, *Combretum molle* and *Dombeya rotundifolia* (Fig. 6c–f). No species is restricted entirely to the four stands making up this community but all extend into the central cluster and two extend into the *Acalypha sonderiana* Nodum as well. Reference to Table 3 shows that in addition to the four species mentioned above, *Spirostachys africana* has a high mean density value in these stands. The stands of the *Aloe candelabrum* Nodum were located in *Aloe-Dombeya* Woodland, described in the general account of the vegetation. Distributions within the ordination of species commonly occurring in the Nodum suggest that its boundaries are not as clearly defined as was indicated in the descriptive account.

TABLE 3.—Mean density and mean local frequency, with standard deviations (s.d.), and constancy for species occurring in more than one of the four stands of the *Aloe candelabrum* Nodum with a mean density greater than unity

Species	Density		Frequency		Constancy
	mean	s.d.	mean	s.d.	
*Aloe candelabrum	74·5	54·7	13·3	3·4	100·0
*Brachylaena elliptica	56·3	20·7	15·0	0·8	100·0
*Combretum molle	44·0	14·6	15·5	0·6	100·0
Spirostachys africana	25·5	15·3	9·3	2·4	100·0
*Dombeya rotundifolia	13·8	8·8	8·5	4·8	100·0
Hippobromus pauciflorus	9·5	10·5	3·8	2·4	100·0
Xeromphis rudis	5·5	5·3	3·8	3·2	100·0
Dichrostachys cinerea	4·8	4·8	3·8	3·4	100·0
Euphorbia ingens	4·8	2·9	4·0	2·6	100·0
Acacia caffra	4·3	2·9	3·8	2·1	100·0
Grewia occidentalis	4·0	4·7	3·3	3·2	100·0
Commiphora harveyi	3·8	3·5	3·5	3·0	100·0
Ehretia rigida	3·8	5·6	2·8	3·6	75·0
Dombeya tiliacea	3·5	4·7	1·3	1·5	50·0
Rhus pentheri	3·0	1·8	3·0	1·8	100·0
Cussonia spicata	2·7	0·9	2·8	0·9	100·0
Maytenus heterophylla	1·8	2·1	1·5	1·7	50·0
Acacia nilotica	1·3	1·5	1·0	1·2	50·0
Total of 17 other species	8·0				
Total mean density	274·5				

* Plotted within the primary ordination

Species with highest mean densities in the *Euphorbia ingens* Nodum (Table 4) are *Euphorbia ingens*, *Dichrostachys cinerea* and *Acacia nilotica*. The area covered by this Nodum was subjected to intense disturbance in the relatively recent past, a possible reason for the low total density and lack of species with high densities. *Acacia nilotica* and *Dichrostachys cinerea* are known to be secondary species and some other species occurring in this Nodum may also be secondary.

TABLE 4.—Mean density and mean local frequency, with standard deviations (s.d.), and constancy for species occurring in more than one of the four stands of the *Euphorbia ingens* Nodum with a mean density greater than unity

Species	Density		Frequency		Constancy
	mean	s.d.	mean	s.d.	
Euphorbia ingens	24·3	8·9	10·0	2·8	100·0
Dichrostachys cinerea	22·5	9·4	10·3	3·3	100·0
Acacia nilotica	11·8	8·9	5·8	4·6	100·0
Canthium ciliatum	9·8	9·4	5·8	4·9	100·0
Grewia occidentalis	8·3	5·1	4·8	2·1	100·0
Xeromphis rudis	7·0	6·1	4·8	1·7	100·0
Acacia robusta	6·5	8·5	3·8	3·9	75·0
Clerodendrum glabrum	6·3	1·3	4·8	1·3	100·0
Rhus pentheri	4·5	2·4	3·8	2·1	100·0
Acacia gerrardii	3·8	4·1	2·5	2·4	75·0
Sclerocarya caffra	3·5	2·4	2·5	0·6	100·0
*Combretum molle	3·3	4·5	2·5	3·0	100·0
Canthium ventosum	3·0	2·2	2·5	1·3	100·0
Euclea natalensis	2·8	3·1	2·0	2·2	75·0
Maytenus heterophylla	2·5	3·9	1·5	2·4	50·0
Ehretia rigida	1·8	2·1	1·8	2·1	50·0
*Brachylaena elliptica	1·5	0·6	1·3	0·5	100·0
Canthium mundianum	1·5	1·7	1·3	1·3	75·0
Commiphora harveyi	1·5	1·7	1·8	1·5	75·0
Total of 20 other species	10·2				
Total mean density	136·0				

* Plotted within the primary ordination

The most common species in the two stands of the *Euphorbia tirucalli* Nodum is *E. tirucalli* (Table 5). Its distribution, shown within the ordination in Fig. 6b, is limited to the stands of this Nodum and the *Acalypha sonderiana* Nodum. Species occurring in both stands but not mentioned in the general account of the vegetation are *Dichrostachys cinerea*, *Acacia robusta*, *Euphorbia ingens*, *Canthium ciliatum*, *Clerodendrum glabrum* and *Protorhus longifolia*. With the exception of *P. longifolia*, which has a low density anyway, these species are also components of the *Euphorbia ingens* Nodum, which surrounds the small *Euphorbia tircucalli* Nodum, so that the stands apparently bridge the ecotone between the two noda. The marked difference between the two noda is, however, still apparent by comparing Tables 4 and 5.

TABLE 5.—Mean density and mean local frequency, with standard deviations (s.d.), and constancy for species occurring in at least one of the two stands of the *Euphorbia tirucalli* Nodum with a mean density greater than unity

Species	Density mean	Density s.d.	Frequency mean	Frequency s.d.	Constancy
*Euphorbia tirucalli	285·0	65·1	16·0	0·0	100·0
Dichrostachys cinerea	14·5	16·3	6·0	4·2	100·0
Acacia robusta	10·5	2·1	7·5	2·1	100·0
Euphorbia ingens	6·5	7·8	3·0	2·8	100·0
Acacia nilotica	5·5	7·8	2·5	3·5	50·0
Canthium ciliatum	3·5	0·7	2·0	0·0	100·0
Clerodendrum glabrum	2·5	2·1	1·5	0·7	100·0
Acacia gerrardii	2·0	2·8	1·5	2·1	50·0
Azima tetracantha	2·0	2·8	1·5	2·1	50·0
Albizia adianthifolia	2·0	1·4	2·0	2·1	100·0
Trema orientalis	2·0	0·0	2·0	0·0	100·0
Dombeya tiliacea	1·5	2·1	1·0	1·4	50·0
Euclea natalensis	1·5	2·1	1·5	2·1	50·0
Grewia occidentalis	1·5	2·1	1·5	2·1	50·0
Protorhus longifolia	1·5	0·7	1·5	0·7	100·0
Ziziphus mucronata	1·5	2·1	1·5	2·1	50·0
Total of 12 other species	4·5				
Total mean density	348·0				

* Plotted within the primary ordination

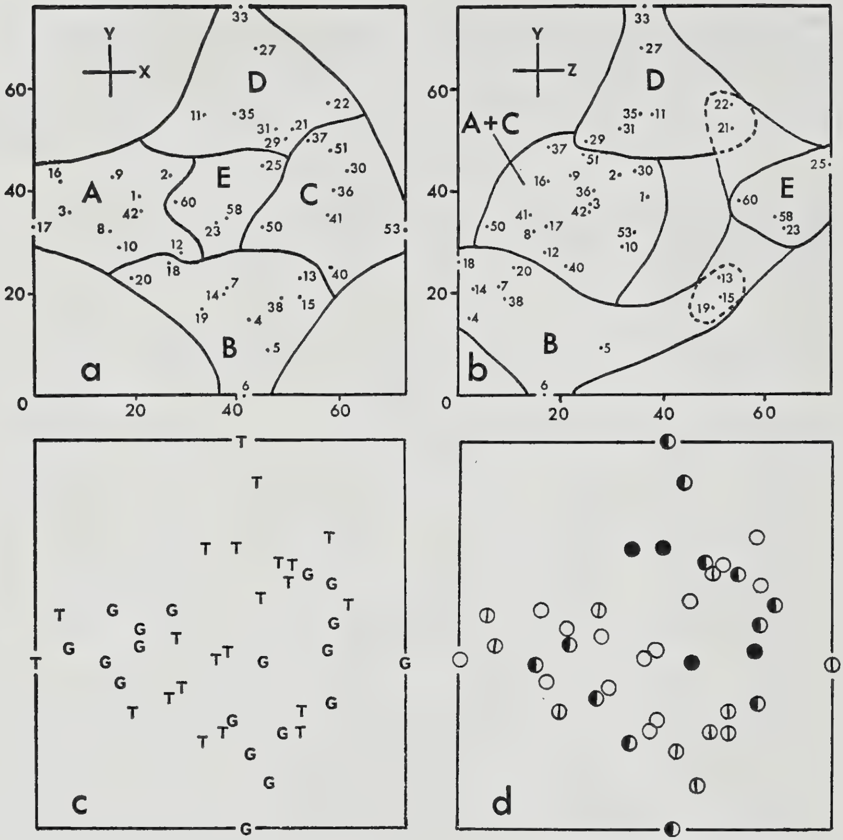
2. *Secondary ordination*

(*a*) *Assessment for noda*

A secondary ordination (Fig. 7a and b) with three axes, X, Y and *Z*, accounted for the variability between the stands constituting the central cluster of the primary ordination (Fig. 3a). Because three axes were required for the secondary ordination, it is not surprising that a meaningful arrangement of stands of the central cluster could not be obtained on the two-dimensional, primary ordination.

Five groups of stands, referred to as noda and named after the species with highest mean densities in the stands of the nodum, are delimited within the secondary ordination. The delimitation was made after inspection of stand position in the field (Fig. 8) and within the ordination, and after inspection of species distributions within the ordination in the same way as for the primary ordination.

As intermediate stands exist between neighbouring noda there are very few real discontinuities within the ordination and other, equally justifiable, delimitations are possible. The secondary ordination also supports the Individualistic Hypothesis of Gleason (1926).



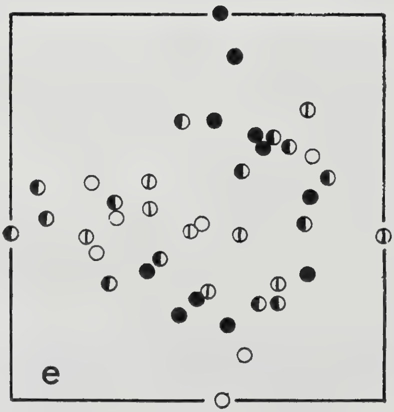
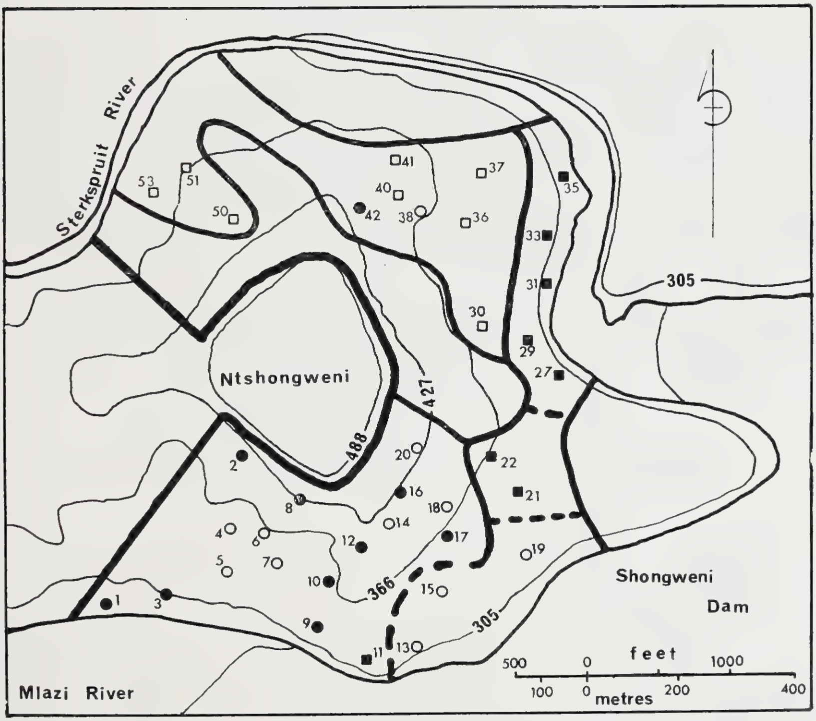


FIG. 7.—a, X–Y axes of the secondary ordination; b, Y–Z axes of the secondary ordination. Numbers refer to stands mapped in Fig. 8 and axes are in percentage dissimilarity. A = **Dombeya tiliacea** Nodum; B = **Hippobromus-Heteropyxis** Nodum; C = **Hippobromus-Spirostachys** Nodum; D = **Spirostachys africana** Nodum; and E = **Euphorbia ingens** Nodum (mapped in Fig. 5); c, distribution of Table Mountain Sandstone (T) and Basement Complex Granite (G) within the X–Y ordination; d, quartile distributions of total density per stand within the X–Y ordination; e, quartile distributions of number of species per stand within the X–Y ordination. See Fig. 4 for key to symbols.

The *Euphorbia ingens* Nodum is discussed under the primary ordination section. Within the X–Y ordination (Fig. 7a), it is centrally placed and would appear closely related to the four surrounding noda. On the Y–Z ordination (Fig. 7b), however, it is shown to be clearly separated from the other noda so that its separation on the primary ordination is justified. The *Euphorbia ingens* Nodum is most closely related to stands 21 and 22 of the *Spirostachys africana* Nodum and stands 13, 15 and 19 of the *Hippobromus-Heteropyxis* Nodum, according to Fig. 7b. The above-mentioned stands lie west and south-west of the peninsula which is covered by the *Euphorbia ingens* Nodum. Inspection in the field showed that, in addition to being close to the peninsula geographically, these five stands were similar, physiognomically and floristically, to the *Euphorbia ingens* Nodum. Being further from the Bantu Kraal site and, therefore, further from a centre of past disturbance, possibly accounts for stands 13, 15, 19, 21 and 22 being, in some ways, intermediate in floristic composition between the *Euphorbia ingens* Nodum and the *Hippobromus-Heteropyxis* and *Spirostachys africana* Noda.



● Dombeya tiliacea Nodum

○ Hippobromus – Heteropyxis ..

□ Hippobromus – Spirostachys ..

■ Spirostachys africana ..

Contour interval: 61 m

FIG. 8.—Map of Ntshongweni showing noda delimited in the secondary ordination.

The two-dimensional ordinations of Fig. 7a and 7b are two projections of a three-dimensional model of the actual forty-dimensional structure so that some distortion of relative stand positions is to be expected. On the Y–*Z* axes, the *Dombeya tiliacea* Nodum and the *Hippobromus-Spirostachys* Nodum are superimposed. The stands of these two communities are, in fact, not intermingled as they appear to be, but lie one behind the other, as shown by the X–Y axes. In the same way, the stands of the *Euphorbia ingens* Nodum on the X–Y axes should not be thought of as lying in the same plane as the other four noda but as either above or below the plane of the other four noda.

Bearing in mind that the *Euphorbia ingens* Nodum is distinct from the other four noda, only the X–Y axes need be used for further discussion of the secondary ordination. The Y–*Z* axes contain less information than do the X–Y axes, as two of the noda which can be recognized in a three-dimensional model overlap on the Y–*Z* axes. A further reason for using the X and Y axes in preference to the Y and *Z* axes is that the former are almost orthogonal while the latter are non-orthogonal.

(*b*) *Relationships of noda to site factors*

Stands 2, 8, 12 and 16 of the *Dombeya tiliacea* Nodum occur under the Ortho-quartzitic cliffs of Ntshongweni where slopes are very steep and soils are derived from both Table Mountain Sandstone and Granite (Fig. 7c). The other stands of this Nodum occur on Granite at lower altitudes, but a deep alluvium overlies the Granite where stands 1 and 3 occur on the edge of the Mlazi River floodplain. Stand 42 of the Nodum occurs on the north-facing side of Ntshongweni on the minor south aspect which can be seen in the aerial photographs (Plate 2). The south-aspect influence is sufficiently strong to give this stand a floristic composition similar to that of stands on the main south-facing slopes.

Surface and subterranean drainage is good on the steep, upper slopes but at lower altitudes where slopes are more gentle, movement of subterranean water is slower so that soil-moisture conditions are more hydric at lower than at higher altitudes. Conversely, atmospheric moisture conditions are more hydric at the higher altitudes because summer fogs, when present, usually clothe only the crest of Ntshongweni. The compensatory effect of soil and atmospheric moisture regimes discussed above is a possible explanation for the similarity, shown by the ordination, between stands from the upper and lower south-facing slopes. Low insolation is a characteristic of all the south-facing slopes.

The *Hippobromus-Heteropyxis* Nodum also occurs on the south-facing slopes of Ntshongweni. Some stands are located between the upper and lower groups of stands of the *Dombeya tiliacea* Nodum and the others occur south-west of the peninsula. Stand 38 occurs next to stand 42 of the *Dombeya tiliacea* Nodum. Most stands occur on Granite. Field inspection showed that the stands of this community occurred on ridges with good surface and subterranean drainage. Stands of the *Hippobromus-Heteropyxis* Nodum are thus probably more mesic, either edaphically or atmospherically, than stands of the *Acalypha sonderiana* and *Aloe candelabrum* Noda which were delimited within the primary ordination.

All but one of the stands of the *Spirostachys africana* Nodum occur on Table Mountain Sandstone, along the lower reaches of the Sterkspruit River. Stands are near a perennial, subterranean water supply and on gently sloping ground so that the moisture content of the soil is good. As most of the stands are east-facing insolation is of intermediate intensity.

(c) Insolation and soil moisture interaction

Measurements of actual soil-moisture content, atmospheric moisture content and quantity of insolation would have to be made to confirm the interactions suggested in Fig. 9. Being on the south-facing slopes, insolation is relatively low in the *Dombeya tiliacea* and *Hippobromus-Heteropyxis* Noda but soil moisture content is probably higher in stands of the *Dombeya tiliacea* Nodum than in those of the *Hippobromus-Heteropyxis* Nodum. Soil moisture content is probably also high in stands of the *Spirostachys africana* Nodum. Conversely, soil moisture content is low on the steep, north-facing slopes occupied by the *Hippobromus-Spirostachys* Nodum. Relatively high insolation is experienced by stands of the *Hippobromus-Spirostachys* and *Spirostachys africana* Noda as they occur on north-, north-west- and east-facing slopes.

Two gradients from hydric to zeric may be thus recognized (Fig. 9). The *Dombeya tiliacea* Nodum which is considered to be most hydric (low insolation and high soil moisture content) grades into the *Hippobromus-Spirostachys* Nodum which is con-

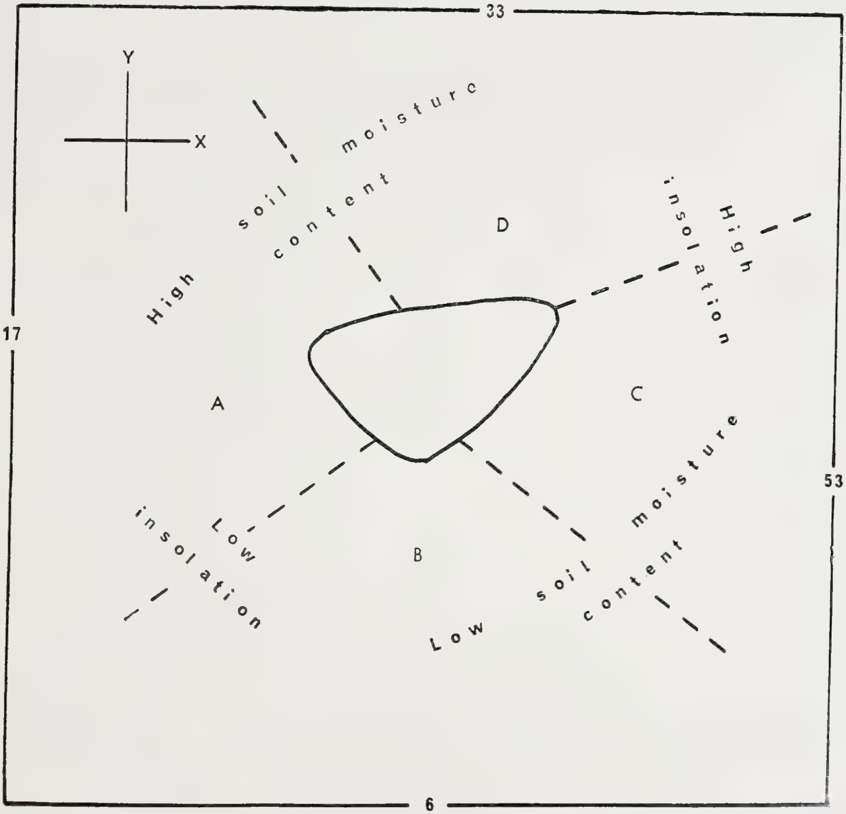


FIG. 9.—Summary of suggested interactions of insolation and soil moisture on the X–Y axes of the secondary ordination. Only positions of end stands are given. A — **Dombeya tiliacea** Nodum: B = **Hippobromus-Heteropyxis** Nodum; C = **Hippobromus-Spirostachys** Nodum; and D = **Spirostachys africana** Nodum.

sidered most xeric (high insolation and low soil moisture content) through the *Hippobromus-Heteropyxis* Nodum (low insolation and low soil moisture content) and the *Spirostachys africana* Nodum (high insolation and high soil-moisture content).

(*d*) *Species behaviour*

Stands of the *Dombeya tiliacea* and *Hippobromus-Heteropyxis* Noda generally have low total densities while high total densities are found in most stands of the *Hippobromus-Spirostachys* and *Spirostachys africana* Noda (Fig. 7d). Stands of all four noda have many species per stand, the lowest number of species per stand being found in stands of the *Dombeya tiliacea* Nodum (Fig. 7e). The *Dombeya tiliacea* Nodum is, therefore, characterized by relatively few species and low total densities. Many species occur in the stands of the other noda, stands of the *Hippobromus-Heteropyxis* Nodum having low total densities and stands of the *Hippobromus-Spirostachys* and *Spirostachys africana* Noda having high total densities. Very few species are restricted in distribution to the stands of any one nodum. As a rule, a species reaches it highest density in the stands of one nodum, but also occurs in the noda on either side.

TABLE 6.—Mean density and mean local frequency, with standard deviations (s.d.), and constancy for species occurring in more than two of the ten stands of the *Dombeya tiliacea* Nodum with a mean density greater than two

Species	Density		Frequency		Constancy
	mean	s.d.	mean	s.d.	
*Dombeya tiliacea	32·5	35·3	9·3	4·9	90·0
Grewia occidentalis	19·5	16·8	9·0	4·7	100·0
*Tricalysia lanceolata	15·7	21·2	4·6	5·5	80·0
Acalypha sonderiana	15·2	24·9	4·8	6·2	60·0
Euphorbia ingens	14·4	31·9	2·5	2·9	80·0
*Ehretia rigida	11·3	15·0	5·3	3·7	90·0
Euclea natalensis	11·1	9·3	6·5	4·5	90·0
*Hippobromus pauciflorus	8·1	10·8	3·9	4·0	80·0
*Brachylaena elliptica	4·9	6·1	2·8	3·0	60·0
*Erythroxylum emarginatum	3·8	3·8	2·8	2·4	70·0
*Azima tetracantha	3·4	3·4	2·8	2·6	70·0
Ptaeroxylon obliquum	3·4	7·8	1·7	3·2	50·0
Rhus chirindensis	3·2	3·5	2·4	2·0	90·0
Canthium mundianum	2·9	4·2	1·1	1·6	50·0
*Dovyalis rhamnoides	2·8	4·1	1·6	2·1	50·0
Xylotheca kraussiana	2·5	4·2	1·7	2·8	40·0
Acacia robusta	2·4	3·5	1·6	1·6	70·0
Maytenus heterophylla	2·4	2·9	1·7	1·8	70·0
Rhus pentheri	2·3	4·3	1·5	2·0	50·0
Ziziphus mucronata	2·3	2·6	2·0	2·2	60·0
*(Protorhus longifolia)	(1·8)	(3·7)	(0·9)	(1·6)	(50·0)
Total of 34 other species	33·8				
Total mean density	197·9				

* Plotted within the secondary ordination

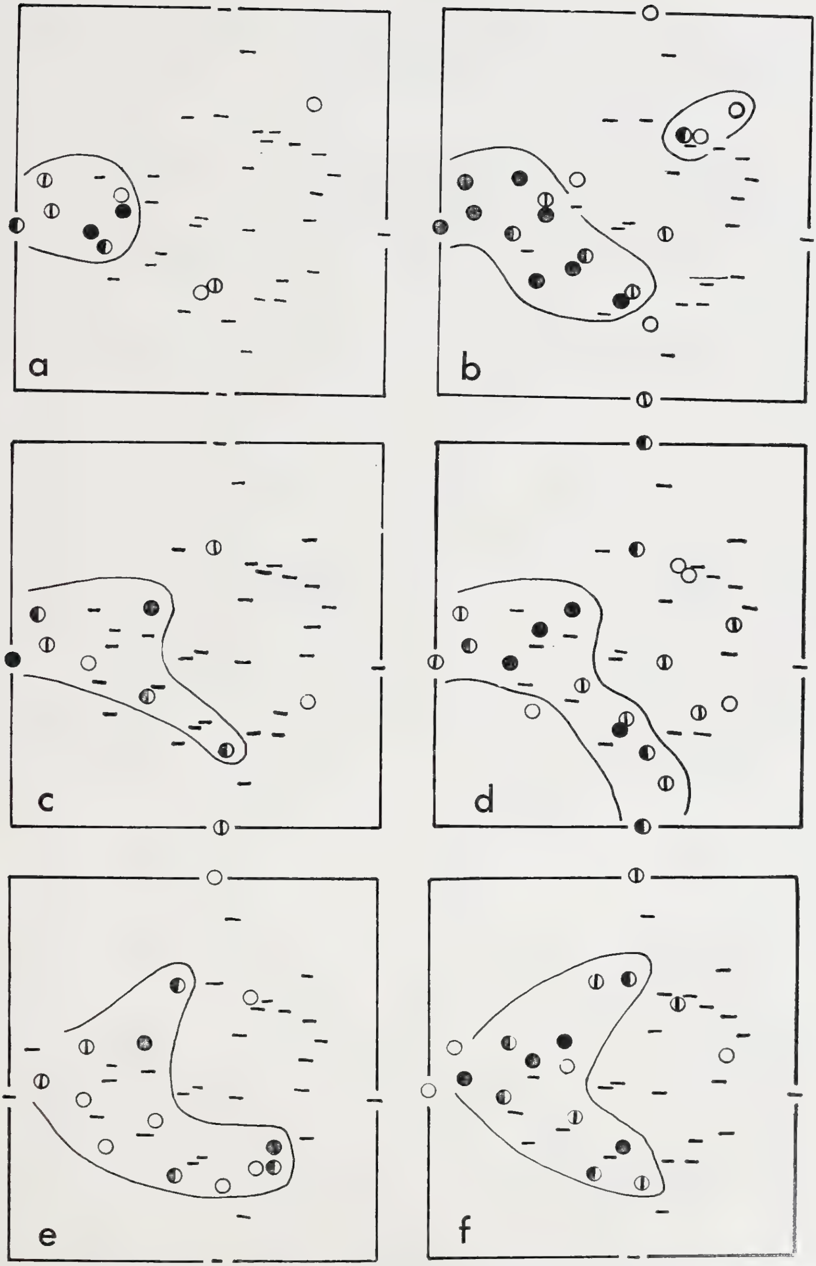


FIG. 10.—Quartile distributions of a, **Azima tetracantha**; b, **Dombeya tiliacea**: c, Dovyalis rhamnoides; d, **Erythroxylum emarginatum**; e, **Protorhus longifolia**; f, **Tricalysia** lanceolata densities within the X–Y ordination. See Fig. 4 for key to symbols.

Species which have distributions centred on the stands of the *Hippobromus-Heteropyxis* Nodum, for example, *Dombeya rotundifolia*, *Heteropyxis natalensis* and *Hippobromus pauciflorus* (Fig. 11 a–c) are widespread throughout the area covered by stands of the secondary ordination.

Species which have distributions centred on the stands of the *Dombeya tiliacea* Nodum include *Azima tetracantha*, *Dombeya tiliacea*, *Dovyalis rhamnoides*, *Erythroxylum emarginatum*, *Protorhus longifolia* and *Tricalysia lanceolata* (Fig. 10). Of these, only *Azima tetracantha* is restricted, almost entirely, to this Nodum. Because the stands of the *Euphorbia ingens* Nodum are in a different plane from those of the other communities, crescent-shaped distribution patterns are shown by many species within this ordination (for example: *Protorhus longifolia* and *Tricalysia lanceolata* in Fig. 10).

TABLE 7.—Mean density and mean local frequency, with standard deviations (s.d.). and constancy for species occurring in more than two of the eleven stands of the *Hippobromus-Heteropyxis* Nodum with a mean density greater than two

Species	Density		Frequency		Constancy
	mean	s.d.	mean	s.d.	
*Hippobromus pauciflorus	60·6	46·6	10·7	5·7	100·8
*Heteropyxis natalensis	38·0	44·0	7·4	6·8	81·8
Grewia occidentalis	26·8	18·5	11·2	5·0	100·0
Combretum molle	9·7	9·8	5·9	4·2	81·9
*Dombeya tiliacea	9·4	13·0	3·9	4·6	54·5
Dichrostachys cinerea	8·9	13·7	3·5	4·7	54·5
*Acacia caffra	8·0	14·7	3·6	5·2	45·5
*Tecomaria capensis	7·3	14·0	2·8	4·6	36·4
*Brachylaena elliptica	6·9	9·2	4·4	3·9	90·9
Acacia nilotica	6·6	8·0	4·1	4·1	81·8
*Dombeya rotundifolia	6·5	6·1	4·5	2·8	90·9
*Ehretia rigida	6·0	6·0	3·6	3·5	90·9
Euclea natalensis	5·6	5·8	3·8	3·6	81·8
Maytenus heterophylla	5·2	4·4	3·7	2·6	100·0
Euphorbia ingens	4·5	4·0	3·6	2·7	90·9
Putterlickia verrucosa	3·6	4·6	2·5	2·9	72·7
Ziziphus mucronata	3·1	3·1	2·6	2·4	100·0
Clausena anisata	2·8	3·3	1·8	2·2	63·6
Fagara capensis	2.5	4·6	1·8	2·9	54·5
*Xeromphis rudis	2.5	2·3	2·1	2·1	63·6
Canthium ciliatum	2.4	6·6	1·1	2·7	27·3
Commiphora harveyi	2.4	1·9	2·3	1.7	72·7
Canthium ventosum	2.2	2·4	1·6	1.9	63·6
Maytenus undata	2.2	3·4	1·7	2.5	45·5
*Tricalysia lanceolata	2.1	4·4	1·5	2·7	27·3
Vangueria infausta	2.1	3·6	1·9	3·1	45·5
Total of 29 other species	25.2				
Total mean density	262.7				

* Plotted within the secondary ordination

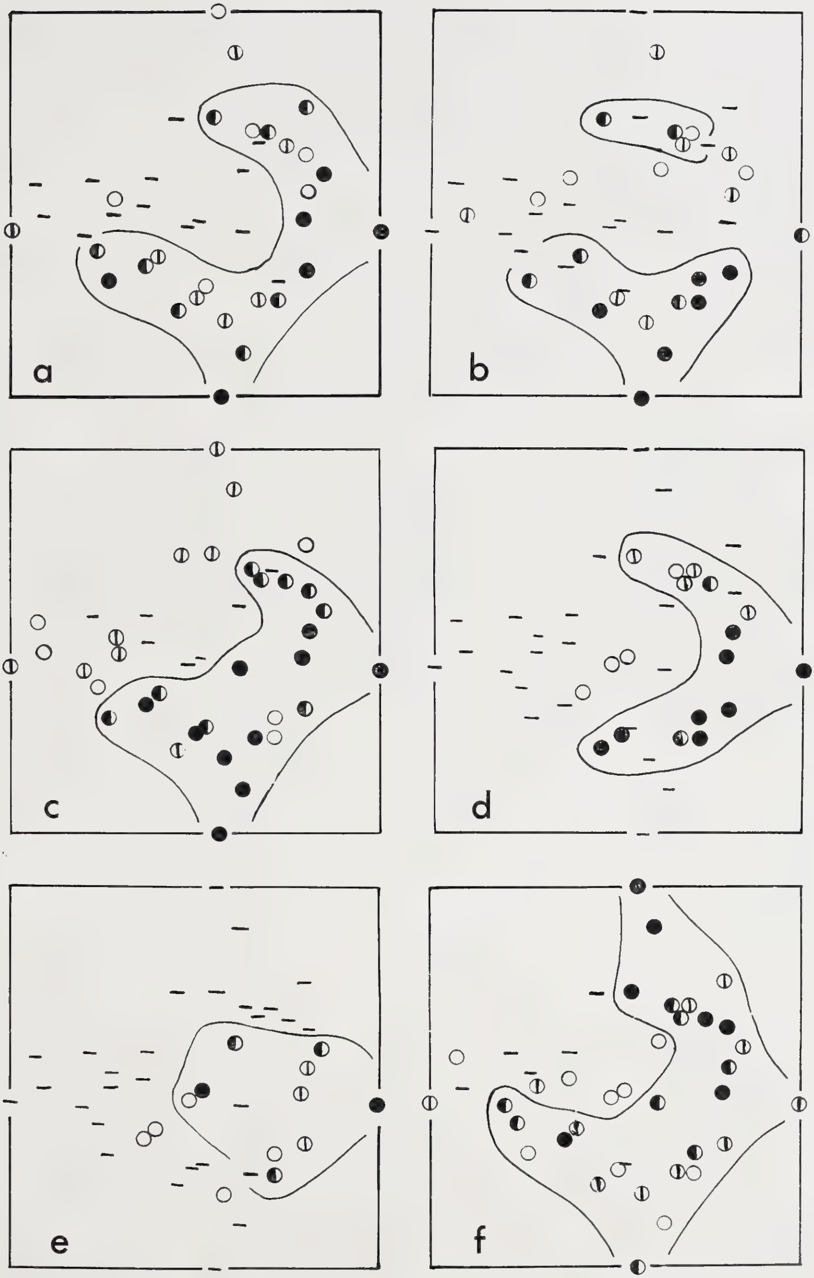


FIG. 11.—Quartile distributions of a, **Dombeya rotundifolia**; b, **Heteropyxis natalensis**; c, **Hippobromus pauciflorus**; d, **Acacia caffra**; e, **Acacia gerrardii**; f, **Brachylaena elliptica** densities within the X–Y ordination. See Fig. 4 for key to symbols.

Apart from species which are plotted within the ordination in Fig. 10, *Grewia occidentalis, Acalypha sonderiana, Euphorbia ingens* and *Euclea natalensis* have high mean densities in stands of the *Dombeya tiliacea* Nodum (Table 6). *Grewia occidentalis* is not p[otted, because it is ubiquitous through the study area, being absent from only two of the 60 stands. *Protorhus longifolia* is included in Table 6, even though it does not qualify for inclusion, as it has a clear pattern of distribution within the ordination and isknown to be a species appearing early in the succession to forest. Its distribution within the study area on the south-facing slopes indicates the area which, in the absence of disturbance, has the potential of being covered by forest.

Apart from the species whose distributions within the ordination are given, *Grewia occidentalis, Combretum molle* and *Dombeya tiliacea* have high mean densities in the *Hippobromus-Heteropyxis* Nodum (Table 7).

TABLE 8.—Mean density and mean local frequency, with standard deviations (s.d.), and constancy for species occurring in more than two of the eight stands of the *Hippobromus-Spirostachys* Nodum with a mean density greater than two

Species	Density		Frequency		Constancy
	mean	s.d.	mean	s.d.	
*Hippobromus pauciflorus	70·1	36·7	12·6	2·7	100·0
*Spirostachys africana	40·5	21·1	12·1	5·3	8·57
Combretum molle	23·1	13·8	10·0	4·1	100·0
Grewia occidentalis	21·9	13·5	10·6	2·9	100·0
*Brachylaena elliptica	16·8	11·2	8·5	3·9	100·0
*Aloe candelabrum	12·6	7·4	6·4	3·9	87·5
*Xeromphis rudis	11·5	6·4	7·5	2·8	100·0
*Ehretia rigida	10·9	8·4	6·3	3·3	100·0
*Acacia caffra	9·8	9·5	5·3	4·4	75·0
Acalypha sonderiana	8·8	8·7	2·0	3·5	37·5
*Dombeya rotundifolia	8·6	8·4	4·9	4·3	87·5
Maytenus heterophylla	7·5	7·0	5·5	3·4	75·0
Canthium mundianum	7·4	7·1	4·0	3·7	75·0
*Heteropyxis natalensis	7·0	5·8	2·4	4·8	62·5
Rhus pentheri	6·6	5·0	5·4	3·3	87·5
Dichrostachys cinerea	4·9	5·4	3·4	3·8	75·0
Euphorbia ingens	4·9	3·0	3·8	2·1	100·0
Euclea natalensis	4·3	1·9	3·9	1·9	87·5
Maytenus undata	4·1	4·7	3·5	3·7	62·5
Putterlickia verrucosa	3·5	3·6	2·3	1·8	75·0
Acacia nilotica	3·1	2·9	2·5	2·3	75·0
*Acacia gerrardii	2·9	3·1	2·4	2·3	62·5
Clausena anisata	2·6	4·6	1·8	3·1	37·5
Ziziphus mucronata	2·5	2·8	2·1	2·3	62·5
Fagara capensis	2·3	1·5	2·0	1·2	87·5
Total of 27 other species	19·2				
Total mean density	317·3				

* Plotted within the secondary ordination

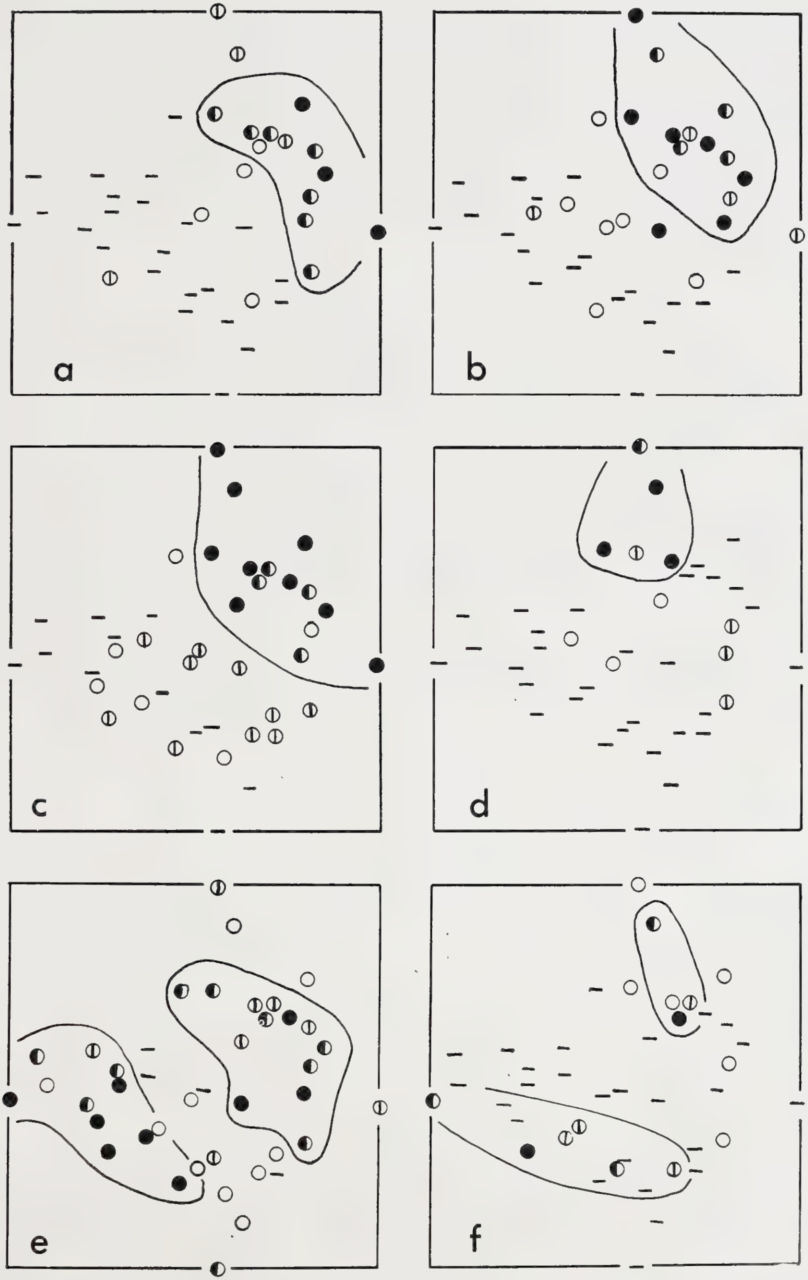


FIG. 12.—Quartile distributions of a, **Aloe candelabrum**; b, **Spirostachys africana**; c, **Xeromphis rudis**; d, **Canthium locuples**; e, **Ehretia rigida**; f, **Tecomaria capensis** densities within the X–Y ordination See Fig. 4 for key to symbols.

Species with relatively high densities and high constancy values in the stands of the *Dombeya tiliacea* Nodum, but are absent from or have low densities in stands of the *Hippobromus-Heteropyxis* Nodum, are *Dombeya tiliacea* and *Tricalysia lanceolata*. *Acacia nilotica*, *Combretum molle*, *Dombeya rotundifolia*, *Heteropyxis natalensis* and *Hippobromus pauciflorus* are absent from, or rare in, the *Dombeya tiliacea* Nodum, but have relatively high densities in the *Hippobromus-Heteropyxis* Nodum.

Acacia caffra, *A. gerrardii* and *Brachylaena elliptica* have distributions centred on the stands of the *Hippobromus-Spirostachys* Nodum (Fig. 11 d–f). *Acacia gerrardii* is restricted, almost entirely, to this Nodum, while *Brachylaena elliptica* has a very wide distribution from the stands of the *Hippobromus-Heteropyxis* Nodum to the *Spirostachys africana* Nodum.

Table 9.—Mean density and mean local frequency, with standard deviations (s.d.), and constancy for species occurring in more than two of the eight stands of the *Spirostachys africana* Nodum with a mean density greater than two

Species	Density		Frequency		Constancy
	mean	s.d.	mean	s.d.	
*Spirostachys africana	43·1	27·4	12·4	4·6	100·0
*Brachylaena elliptica	19·1	16·2	8·9	5·9	87·5
*Xeromphis rudis	17·3	10·6	9·0	4·4	100·0
Combretum molle	14·5	8·2	7·8	2·3	100·0
*Hippobromus pauciflorus	14·0	15·6	5·1	4·6	87·5
Clausena anisata	13·0	13·2	4·5	3·5	87·5
Grewia occidentalis	12·9	7·3	7·5	2·2	100·0
*Aloe candelabrum	10·5	14·7	5·3	4·7	87·5
Canthium mundianum	9·1	9·4	4·5	2·9	100·0
Euphorbia ingens	8·1	5·3	4·6	2·5	100·0
Ochna arborea	7·3	8·4	4·0	4·0	75·0
Euclea natalensis	6·3	4·2	4·4	2·8	87·5
Xylotheca kraussiana	6·3	15·0	2·1	4·2	37·5
*Canthium locuples	6·1	7·3	2·9	3·6	62·5
*Tecomaria capensis	6·1	7·3	4·0	4·6	62·5
Dichrostachys cinerea	5·9	5·8	3·5	3·2	75.0
Acacia nilotica	5·5	5·1	4·6	4·4	62.5
*Ehretia rigida	5·5	3·0	4·6	2·5	100.0
Acalypha sonderiana	5·3	8·7	1·5	2·7	50·0
Maytenus undata	4·9	7·7	3·6	4·3	75·0
Maytenus heterophylla	4·6	5·7	2·9	3·2	62·5
Putterlickia verrucosa	4·4	4·1	3·3	2·6	87·5
Muriea discolor	4·1	10·9	1·1	2·5	37·5
Rhus pentheri	3·9	3·6	2·3	2·1	100·0
Canthium ventosum	3·5	3·7	2·6	1·9	87·5
*Heteropyxis natalensis	3·0	3·9	1·9	2·2	62·5
Canthium ciliatum	2·8	5·0	2·1	3·3	75·0
*Dombeya rotundifolia	2·7	2·6	2·5	2·3	75·0
Total of 27 other species	28·6				
Total mean density	278·3				

* Plotted within the secondary ordination

Apart from the species after which the *Hippobromus-Spirostachys* Nodum is named and species plotted within the ordination, *Grewia occidentalis*, *Combretum molle* and *Dichrostachys cinerea* have high mean densities (Table 8).

Aloe candelabrum, *Spirostachys africana* and *Xeromphis rudis* (Fig. 12 a–c) occur in both the *Hippobromus-Spirostachys* and the *Spirostachys africana* Noda. *Canthium locuples* (Fig. 12d) is restricted, almost entirely, to the *Spirostachys africana* Nodum while *Ehretia rigida* and *Tecomaria capensis* (Fig. 12e and 12f) occur in the stands of the *Spirostachys africana* Nodum and on the south-facing slopes of Ntshongweni. Apart from species plotted within the ordination, *Combretum molle*, *Clausena anisata* and *Grewia occidentalis* have high mean densities in stands of the *Spirostachys africana* Nodum (Table 9).

General Conclusions

Ordination was successful in aiding the writer's understanding of the vegetation and more knowledge was gained about the vegetation than if a descriptive survey alone had been carried out. Too much variation was inherent in the vegetation for it to be illustrated in two or three dimensions as used by Whittaker (1960) and by Bray & Curtis (1957). Two ordinations, using a total of five dimensions and a modified method of end stand selection, were required. Thus, used with discretion, ordination was a valuable tool in the study of this subtropical vegetation.

Correlations between species behaviour, illustrated by a stand ordination, and certain site factors were proposed. Actual measurements of factors, like quantity of insolation and soil moisture content, necessary to substantiate the proposed correlations, were precluded by a lack of time. Such measurements would have to be included in a more thorough investigation.

Evidence in support of the Individualistic Hypothesis is given, particularly by the secondary ordination. Although it was possible to delimit noda, it was shown that site factor and floristic gradients exist between noda.

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An Investigation of the Plant Ecology of the Hawaan Forest, Natal, using an Ordination Technique

by

E. J. Moll

Abstract

An account of the forest ecology using a slightly modified Wisconsin ordination technique (Bray & Curtis, 1957) is given. The river-facing slope is considered preclimax, and the sea-facing slope subclimax, to the climax forest on the flat land. In addition, a secondary element, resulting either from recent disturbance or, possibly, from recently drier environmental conditions, is shown to be present in the climax forest.

Introduction

In recent ecological literature there has been a swing away from traditional descriptive ecological accounts towards quantitative methods of analysis. One of these methods, the modified Wisconsin ordination technique developed by Bray & Curtis (1957), was investigated with the aim of testing its usefulness when applied to South African vegetation, particularly forest. This technique can be used to compare quantitatively floristic data for different stands or examples of vegetation, and assumes that the floristic composition of a site is an expression of the environment of that site. Vegetation samples are compared one with another, to obtain an Index of Similarity $C = \frac{2w}{a + b} \times 100$, where *w* is the sum of the lesser scores for each species common to both stands, and *a* and *b* are the sum of the scores for each sample.

The sample plots are then arranged along axes, in this study two axes X and Y, so that the linear distance between plots is an indication of relative similarity or dissimilarity between plots. Because the method of endplot selection used by Bray & Curtis (1957) did not make efficient use of factor space, endplots with high mean dissimilarities and high standard deviations of the mean were used (Morris, 1967; 1969).

Methods

Data, suitable for ordination, were collected during an investigation of the Hawaan Forest (Moll, 1968a). This Forest is situated close to the sea on the North Coast highway, approximately 10 miles (16·1 km) north of Durban at the intersection of co-ordinates 29° 42′ south and 31° 06′ east. The Forest occurs on a flat area which slopes eastwards down to the sea in one direction, and steeply northwards to the Mhlanga River in the other direction (Moll, 1968b). The area analysed consists of some 100 acres (40·5 ha) of Coast Forest on sandy dune soils. Density data for trees and shrubs, i.e. the number of stems per plot, were collected from fifty 33 ft (10·1 m) square plots constituting a total sample of approximately 1·3 per cent of the Hawaan Forest. Woody plants with a diameter at breast height (d.b.h.) of at least three inches (7·6 cm) or at least 15 ft (4·6 m) high, were considered trees. All smaller woody plants were

considered shrubs. The fifty plots were located by restricted randomization, a grid being superimposed on a large scale map of the Forest, and three plots were located within each grid square by pacing out two random co-ordinates.

Results

Two axes, X and Y, were sufficient to account for most of the floristic variation between samples of the trees and shrubs. The two-dimensional scatter diagrams, where points represent sample plots, are shown in Figs. 1–3. Isolines have been employed to draw attention to high and low values. Correlation coefficients between 200 randomly selected interpoint distances and their corresponding calculated dissimilarity values were found to be significant, with a value of 0·61 on the tree ordinations (Figs. 1 and 2), and a value of 0·50 on the shrub ordination (Fig. 3). This significant correlation indicates that most variation within the data is accounted for by the X and Y axes used.

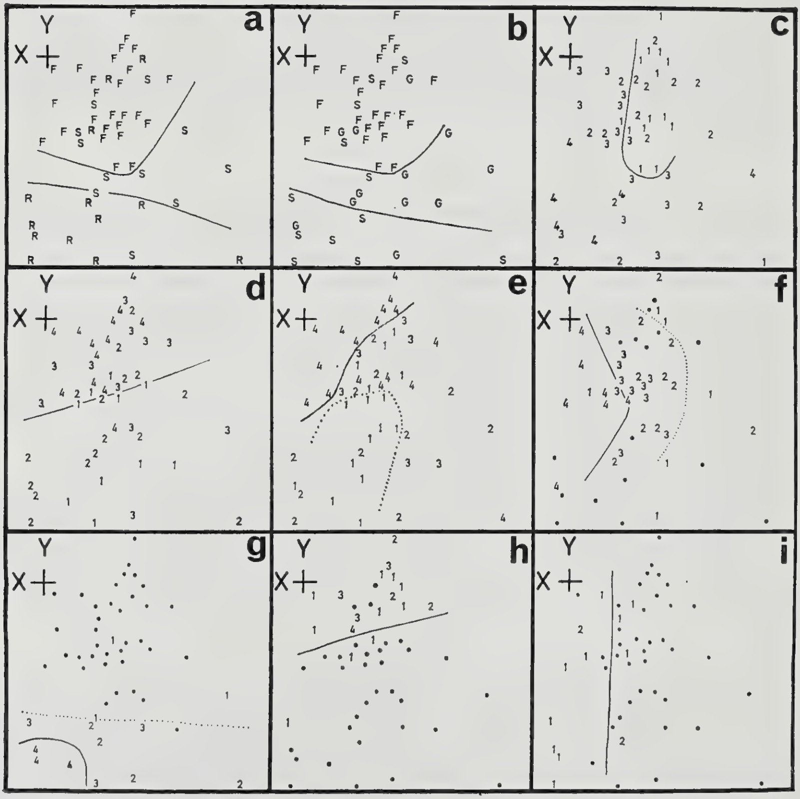

Fig. 1.—Tree ordination showing the distribution of: a, plot aspect (F = flat, S = sea, R = river); b, angle of slope (F = flat, G = gentle, S = steep); c, canopy tree density (1 = 2–4, 2 = 5–6, 3 = 7–10, 4 = 11–18); d, estimated mean tree height in feet (1 = 20–23, 2 = 24–26, 3 = 27–29, 4 = 30 and more); e, estimated d.b.h. in inches (1 = less than 4, 2 = 4–5·9, 3 = 6–8, 4 = 8·1 and more); f, **Cola natalensis** (. = absent, 1 = 1, 2 = 2, 3 = 3, 4 = 5–6); g, **Xylotheca kraussiana** (. = absent, 1 = 1, 2 = 2, 3 = 3, 4 = 4–5); h, **Cavacoa aurea** (. = absent, 1 = 1, 2 = 2, 3 = 3, 4 = 5); i, **Celtis africana** (. = absent, 1 = 1, 2 = 2).

Figs. 1a and 1b show the distribution of two environmental factors, aspect and angle of slope, which were estimated for each sample plot while in the field. The Y axis of the ordination is mainly responsible for separating the flat plots, the gentle sea-facing plots and the steep river-facing plots. There are, apparent however, certain anomalies which should be explained. The sea-facing plot and the two river-facing plots at the upper extreme of the Y axis are undisturbed forest. The remaining river-facing plot and three sea-facing plots, which are apparently similar to the flat plots, do in fact have high coefficients of dissimilarity, but a third axis would be necessary to expose these differences. Such discrepancies are understandable when one considers that a multidimensional system has been expressed in two-dimensions.

Fig. 1c shows that the tree densities are related to both the X and Y axes. The exact relationship between aspect and density is not clear, but it is apparent that the majority of the most dense plots are river-facing and sea-facing. Some flat plots do, however, have a high density.

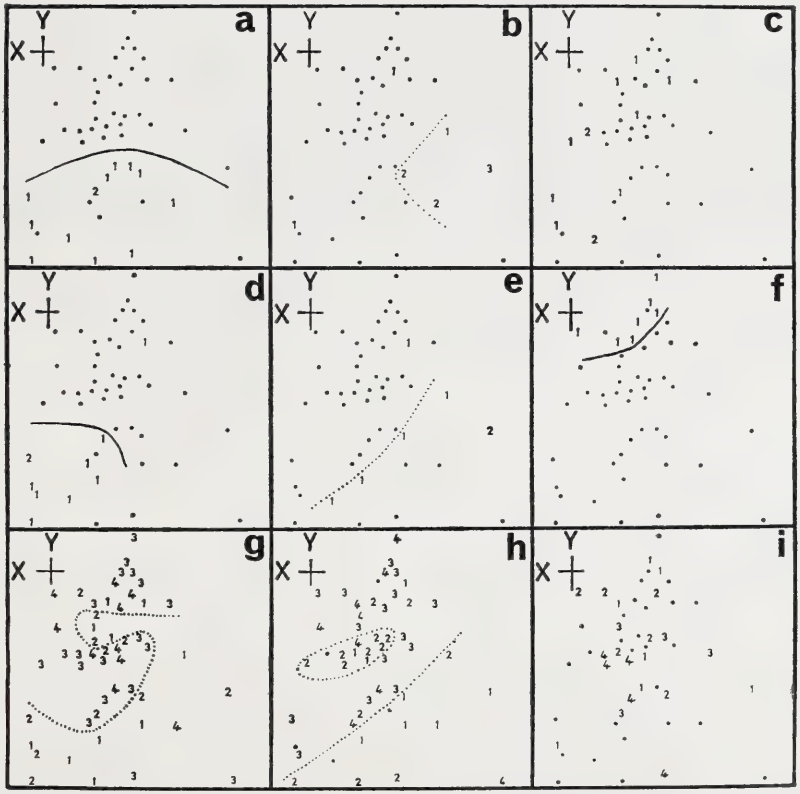

FIG. 2.—Tree ordination showing the distribution of: a, **Drypetes natalensis** (. = absent, 1 = 1, 2 = 2); b, **Teclea gerrardii** (. = absent, 1 = 1, 2 = 2–3, 3 = 5); c, **Dovyalis** sp. nov. (. = absent, 1 = 1, 2 = 2); d, **Deinbollia oblongifolia** (. = absent, 1 = 1, 2 = 3); e, **Mimusops obovata** (. = absent, 1 = 1, 2 = 2); f, **Strychnos decussata** (. = absent, 1 = 1); g, shrub density (1 = 6–18, 2 = 24–37, 3 = 41–69, 4 = 70–88); h, **Uvaria caffra** (. = absent, 1 = 1, 2 = 2–4, 3 = 6–9, 4 = 10–30); i, **Peddiea africana** (. = absent, 1 = 1, 2 = 2, 3 = 3, 4 = 4–12).

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Estimated canopy height has been plotted in Fig. 1d, the tallest trees occurring in the flat plots. Fig. 1e shows the mean estimated d.b.h., the largest trees being in the flat plots.

Figs. 1f and 1i, and Figs. 2a–2f, show the distribution of the ten tree species with the highest densities on the ordination. One species, *Strychnos innocua*, is not illustrated here as it shows no relationship to the major environmental situations considered here and apparently has a random distribution. *Cola natalensis* (Fig. 1f) occurs mainly in those flat and sea-facing plots which have the highest tree density. *Xylotheca kraussiana* (Fig. 1g) occurs almost exclusively in the steep river-facing plots where the trees are generally small and with a high density, although two sea-facing plots and one flat plot do each contain only a single specimen. *Cavacoa aurea* (Fig. 1h) occurs in flat, sea- and river-facing plots which are gently sloping, though two steep-river-facing plots do each contain a single tree. The plots containing *C. aurea* vary in density, but contain the largest forest trees. *Celtis africana* (Fig. 1i) has a similar distribution on the ordination to *Cola natalensis*, but is confined mainly to the most dense plots. *Drypetes natalensis* (Fig. 2a) is generally limited to the sea- and river-facing plots, where the trees are predominantly small and fairly dense. *Teclea gerrardii* (Fig. 2b) is found mainly in the sea-facing plots with moderate density and medium-sized trees. *Dovyalis* sp. nov. (Fig. 2c) has a fairly random distribution on the ordination and is similar to *Cola natalensis*. *Deinbollia oblongifolia* (Fig. 2d) is limited entirely to river-facing plots and to two sea-facing plots where the trees are small and dense. *Mimusops obovata* (Fig. 2e) occurs mainly in the sea-facing plots, but also occurs in two of the river-facing plots. *Strychnos decussata* (Fig. 2f), with the exception of one river-facing plot, occurs exclusively in flat plots of low density and big trees.

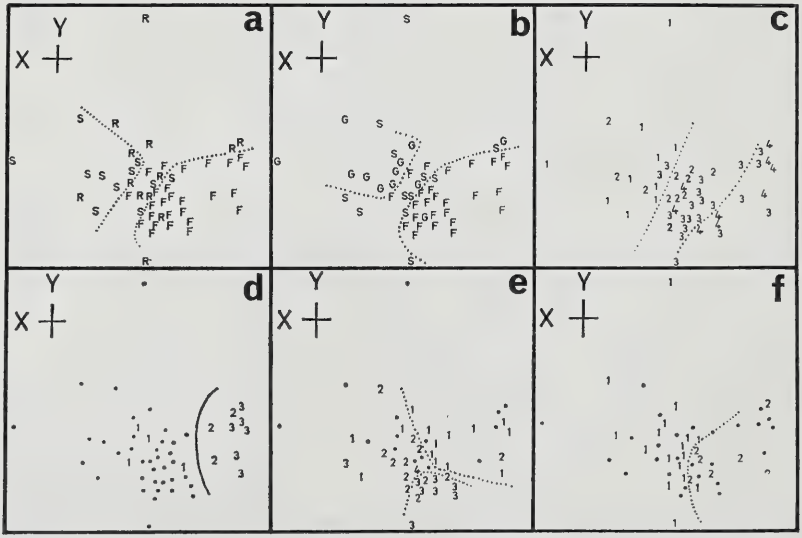

FIG. 3.—Shrub ordination showing the distribution of: a, plot aspect (F = flat, S = sea, R = river); b, angle of slope (F = flat, G = gentle, S = steep); c, shrub density (1 = 6–18, 2 = 24–37 3 = 41–69, 4 = 70–88; d, **Notobuxus natalensis** (. = absent, 1 = 1–5, 2 = 12–26, 3 = 34–52); e, **Baphia racemosa** (. = absent, 1 = 1–4, 2 = 5–10, 3 = 11–30, 4 = 61); f, **Carissa bispinosa** (. = absent, 1 = 1–2, 2 = 3–7).

Fig. 2g shows the shrub density data plotted on to the canopy tree ordination. No clear trends are discernible, but this is understandable because the shrub species are not as dependent on the external environment as are the tree species. It is apparent, however, that most river plots have a comparatively low shrub density.

Figs. 2h and 2i show the distribution of two selected shrub species, *Uvaria caffra* and *Peddiea africana*, on the tree ordination. Neither shows any marked relationship to the tree species performance. These two shrub species are given as examples of the unclear relationship between shrub and tree layers.

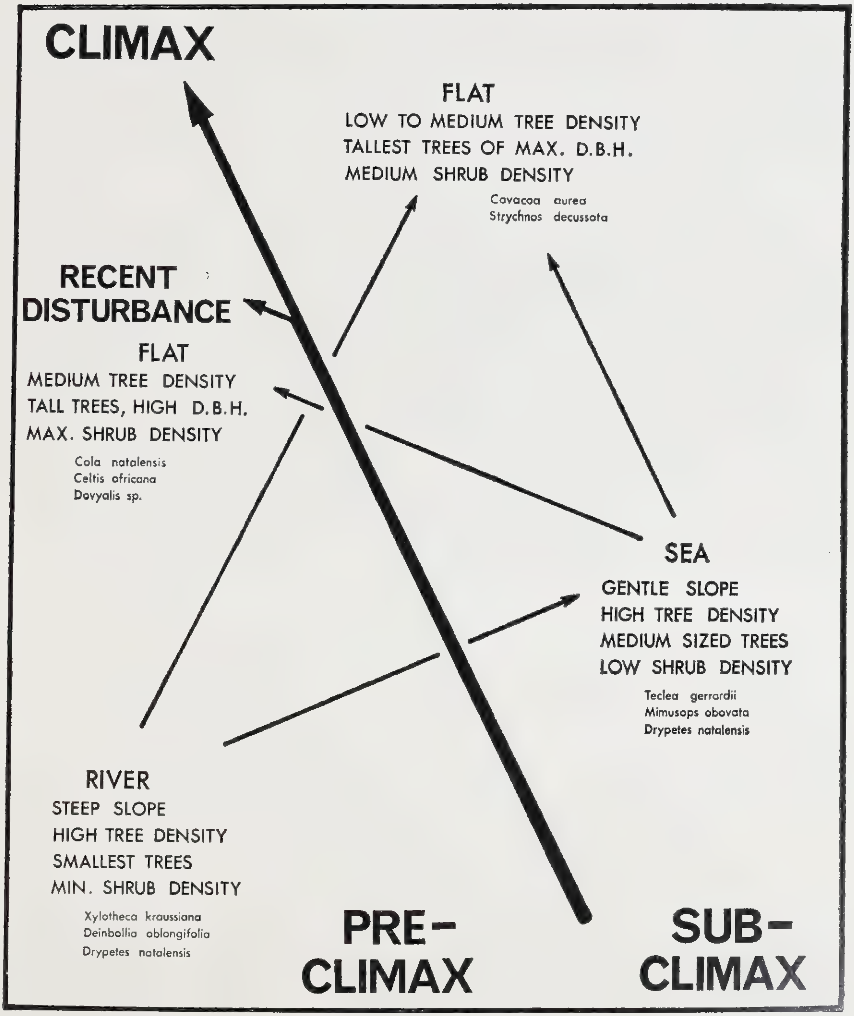

FIG. 4.—Diagrammatic summary, from the tree ordination, of suggested ecological gradients.

Figs. 3a and 3b show the distribution of aspect and angle of slope on the shrub ordination. The relationships between these two environmental factors are not as clear on the shrub ordination as they were on the tree ordination. A diagonal relationship to the two axes separates most of the gently-sloping to steeply-sloping, sea and river plots from the flat plots.

Fig. 3c shows the shrub density on the ordination. The relationships are not clear, but the flat plots tend to have the highest densities of shrubs.

Figs. 3d to 3f show the distribution of selected shrub species on the ordination. Only three species are shown. These are representative of the unclear shrub patterns on the ordination that appear to be unrelated to any of the major environmental data considered here. *Notobuxus natalensis* (Fig. 3d) is the one exception and shows a clear pattern, occurring in the flat plots where it contributes markedly to the high shrub density.

The results of the tree ordination are briefly summarized in Fig. 4, and suggested successional relationships are also given.

Discussion

By considering the limited environmental data that were collected in the field together with the tree density data and species behaviour, and with some experience of species performance in other parts of Natal, it is postulated that the forest on the flat sites represents the highest stage of development and can be considered climax. It is on the flat land that soils are deepest and where maximum penetration of rain water occurs. The rather varied tree density in some of the flat plots was at first a little perplexing but, when canopy tree species were plotted on to the ordination, it was apparent that either recent disturbance, by way of the occasional removal of a tree, or by a natural tree-fall, or recently drier environmental conditions, accounted for the much higher density in these plots. The shrub density data also indicated that there had been some recent disturbance, as many of the flat plots had a dense shrub layer indicative of a disturbed canopy. In fact, plots at the upper end of the Y axis may be considered as the best climax forest. The forest on the sea-slope may be considered a subclimax, limited by salt-spray, and the forest on the north-facing river slope, which is a xerocline, may be considered as preclimax.

Considering the canopy trees, it is postulated that *Cavacoa aurea* and *Strychnos decussata* (Fig. 1h and 2f) are true climax species in Hawaan.

Xylotheca kraussiana and *Deinbollia oblongifolia* (Fig. 1g and 2d) are heliophytes which occur almost exclusively in river plots. An occasional tree occurs on the sea-facing slope or on flat land, probably in an old gap.

Drypetes natalensis (Fig. 2a) occurs in an equal number of sea- and river-facing plots, and in two flat plots. It appears that this species prefers a fair amount of light, as the two flat plots where it is found are towards the seral end of the Y axis.

Mimusops obovata (Fig. 2e), a species that favours xeric sites, occurs mainly in the sea-facing plots, but is also present on the river slope. It occurs at the upper end of the Y axis and is probably indicative of subclimax forest.

Teclea gerrardii (Fig. 2b) has a similar behaviour to *M. obovata*, but is almost completely confined to sea-facing plots.

Cola natalensis has the highest density and is the most frequent species in Hawaan. Its distribution on the ordination (Fig. 1f) is across the successional trend postulated (see Fig. 4), being found mainly in flat plots, but it also occurs in sea- and river-facing

plots. From field observations it was apparent that most *C. natalensis* trees were fairly small and I suggest that the frequency of *C. natalensis* is due to recent disturbance. This suggestion is partly supported by the shrub density data where the plots with the highest densities of shrubs are related to the distribution of *C. natalensis*.

The last two species, *Celtis africana* (Fig. 1i) and *Dovyalis* sp. (Fig. 2g), have a similar distribution to *Cola natalensis* although less well defined. *Celtis africana* is a fairly fast-growing tree which can tolerate both open canopy conditions and drier environmental conditions, as can also *Dovyalis* sp.

It is obvious that some relationship exists between the river xerocline and the sea-slope, the former probably bearing a seral relationship to the latter. This relationship is shown by the distribution of *Xylotheca kraussiana* (Fig. 1g), *Deinbollia oblongifolia* (Fig. 2d) and *Mimusops obovata* (Fig. 2e) on the ordination.

The distribution of shrub data on the canopy and the shrub ordinations was not clear and, at the present level of investigation, the shrubs are not as ecologically meaningful as the trees. A possible reason for this is that the shrubs, being partly protected by the trees, are not as dependent on the external environment. In addition, the shrub layer is more sensitive to local disturbance, such as the occasional removal of trees and natural treefalls. A combination of these factors has masked the shrub behaviour. Only the distribution of *Notobuxus natalensis* (Fig. 3d) was clear, this species being found exclusively in flat plots under the best canopy.

Conclusions

The climax forest species growing on flat sites are the tallest trees with maximum d.b.h. Most important climax species are *Cavacoa aurea* and *Strychnos decussata*. The forest of the gently-sloping sea slope is subclimax, and the most important sub-climax species are *Teclea gerrardii*, *Mimusops obovata* and *Drypetes natalensis*, the last species occurring on both the river and sea slopes (Fig. 4). The forest of the steep river slopes is at a preclimax to that on the flat sites, typical species being *Xylotheca kraussiana* and *Deinbollia oblongifolia*.

The modified Wisconsin ordination technique has given a good indication of the behaviour of the plant species considered. The manner in which this has been achieved is by simple, pictorial illustrations of the relationships of the plant species to certain environmental factors. The results of a previous investigation, based on density and frequency values, of the forest ecology (Moll, 1968a), were similar, but less obvious, in spite of the presence of the three distinct topographic sites in the Hawaan Forest. It is possible that if the size of the sample plot was manipulated to get the optimum size of sample, the results may have been even more informative.

Certain more refined statements concerning the plant ecology have been possible with the ordination technique than were possible with the previous study by Moll (1968a). A good example of this is that the ordination showed that *Cola natalensis*, *Celtis africana* and *Dovyalis* sp., although common in climax forest, are not true climax species, but can occur where there is comparatively recent disturbance. Such a conclusion was not easily drawn from a previous study of the Forest.

Acknowledgements

In particular I wish to thank Dr. D. F. Woods of the Botany Department, University of Natal, Pietermaritzburg, who introduced me to ordination, and to Mr. J. W. Morris for much valuable advice. I would like to acknowledge the use of the facilities of the Botany Department, University of Natal, Pietermaritzburg. Finally, I would like to express my very sincere thanks to Dr. D. Edwards for his many valuable criticisms and comments.

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Book Review

FIGS (FICUS SPP.) of HONG KONG by DENNIS S. HILL. *Hong Kong: Hong Kong University Press.* 1967. *Pp. viii* + 128, 178 *figures*, 4 *tables*, 65 *black and white plates. Price HK* $60.

It has been known for a long time that a unique symbiotic relationship exists between chalcid wasps belonging to the family Agaonidae and plants of the genus *Ficus*: the agaonid wasps can only develop in the gall flowers of the figs and the insects are the sole means of pollination for the fig flowers and are hence responsible for maturation of the fruit.

Dr. Hill, an entomologist, has made a careful study of the association between the figs and fig-wasps of Hong Kong. The investigation, which lasted three years, involved making continuous ecological observations on 200 trees representing 27 species of *Ficus*, 14 of which produced fertile fruit. In all, Dr. Hill collected over 25,000 figs from which he obtained 65 species of chalcid wasp plus numerous other insects. Dr. Hill was fortunate in being able to enlist the aid of Professor E. J. H. Corner of Cambridge, expert on the Asian and Australasian species of *Ficus*, in identifying the Hong Kong species.

Following his Introduction and Methods in Chapters 1 and 2 respectively, Dr. Hill discusses in Chapter 3 the characteristics, fig anatomy and pollination of the genus *Ficus*, and provides a systematic list of the Hong Kong figs as well as a key to species.

Chapter 4, which comprises the bulk (90 pages) of the book, contains a description of the morphology and ecology of the Hong Kong *Ficus* species. In Chapter 5 a provisional synoptic catalogue of world genera of fig-wasps is provided.

In Chapter 6 Dr. Hill tabulates the different chalcid species that were collected from the 14 infected species of *Ficus* and comes to the extremely interesting conclusion that, under natural conditions, the Agaonidae of Hong Kong are completely host specific. In the Sycophaginae, however, host specificity does not appear to be the rule.

Chapter 7 is devoted to a discussion of the high degree of adaptive radiation shown by the Hong Kong *Ficus* species, their dispersal and the origin, evolution and migration of *Ficus*.

Chapter 8 comprises a useful bibliography, which is intended to contain all the more important contributions towards a study of *Ficus* species (except *F. carica*) and fig-wasps.

In Chapter 9, which is an appendix, the previous names for the Hong Kong species of *Ficus*, and the Ficus species recorded from China, Taiwan, Ryuku Islands and Japan are tabulated. Chapter 10 comprises an index to the species of *Ficus* and genera of fig-wasps.

There are 178 excellent figures and 65 black and white photographs of varying quality.

The thought comes to mind that if host specificity in the Agaonidae is a general rule, then a study of the South African agaonids occurring in our fig species might assist in deciding whether some of the alleged differences between closely related species such as *Ficus burkei* (Miq.) Miq., *F. natalensis* (Miq.) Hochst., *F. petersii* Warb. and *F. craterostoma* Warb. ex Mildbr. & Burret are valid. Although the revision of the South African figs is in the capable hands of Dr. De Wolf of Georgia, U.S.A., such a study would serve as an invaluable check. It is to be hoped that some entomologist in this country will undertake an investigation of the figs and fig-wasps of South Africa. Dr. Hill's study would serve as an admirable model.

D. J. B. KILLICK

PLATE 1 — Illtyd Buller Pole Evans.

Bothalia 10, 2 : 131 — 135

Illtyd Buller Pole Evans (1879 - 1968)

by

M. D. Gunn

Illtyd Buller Pole Evans C.M.G., M.A. (Cantab.), D.Sc. (Wales), LL.D. (Rand), F.L.S., pioneer in botanical research in South Africa, died in his ninetieth year on 16th October, 1968, at Umtali, Rhodesia. Born at Llanmaes near Cardiff, Wales, on 3rd September, 1879, he was the son of an Anglican clergyman, Rev. Daniel Evans, M.A., whose wife Caroline Jane Pole came from a very old West Country family.

After attending Cowbridge Grammar School he entered the University College of South Wales and Monmouthshire, graduating with the degree of B.Sc. in 1903. He proceeded to Cambridge (Selwyn College) as a research student in botany, specializing in mycology and plant pathology under Prof. H. Marshall Ward F.R.S., gaining his research degree in 1905. In July of the same year he was appointed to the post of Mycologist and Plant Pathologist in the newly constituted Transvaal Department of Agriculture in Pretoria, where he joined J. Burtt Davy who, two years earlier, had been appointed as Chief of the Division of Botany.

It was a case of starting from zero and, in spite of severe difficulties imposed by lack of office accommodation and laboratory facilities, a programme of research was soon under way in a make-shift greenhouse near his office, and at Skinners Court Experiment Station near Pretoria, on rusts in cereals and other plant diseases. The results were published in a steady flow of scientific papers and popular articles dealing with mycology and plant disease problems in the Transvaal, and he also found time to give advice to neighbouring territories.

In 1912 his services received recognition from the Union Government with the creation of the Division of Mycology and Plant Pathology under his charge. The following year improved accommodation for the Division became available at Vrede Huis, situated in eight acres of ground at the foot of Meintjies Kop, on which the Union Buildings were in process of being constructed.

The year 1913 saw further changes when, with the retirement of Burrt Davy, the Division of Botany was amalgamated with the Division of Mycology and Plant Pathology, and the Transvaal Colonial Herbarium was transferred to Vrede Huis. In the same year, under an agreement with Medley Wood, the Division took over control of the Natal Herbarium at Durban, with sufficient ground for carrying out experiments on tropical and subtropical crops. At this time his staff consisted of three mycologists: Dr. Ethel M. Doidge, appointed in 1908; Dr. P. A. van der Bijl, appointed in 1911, who became Mycologist in Charge of the Natal Herbarium and later Professor of Plant Pathology at Stellenbosch University; and Miss A. M. Bottomley, appointed in 1913. In addition there was Miss S. M. Stent, appointed in 1904 in Burtt Davy's Division, who was in charge of the phanerorgamic herbarium and economic section of the Division.

In the early days of his career in South Africa, Pole Evans became keenly interested in the rich flora of the country. At first he paid special attention to Aloes, which he brought together in the grounds of the Division, resulting in probably the largest collection of South African species then in existence. In 1915 and 1917 he published descriptions of many new species of Aloe in the Transactions of the Royal Society of South Africa. Cycads *(Encephalartos)* also claimed his attention and specimens which he collected still stand in the grounds of the Division and at the Union Buildings.

An example of the strong and decisive action which he was always prepared to take occurred in 1916 when Citrus Canker was reported in the Transvaal. The disease spread rapidly and drastic action, involving the destruction of infected nurseries and commercial orchards, was called for. After a lengthy campaign, involving large sums of money spent in compensation, the Division succeeded in completely eradicating the disease which otherwise would have had a crippling effect on the citrus industry.

Another problem referred to Pole Evans concerned the serious wastage experienced in shipments of citrus fruits during 1919. In 1920 he published his findings in his "Report on Cold Storage Conditions for Export Fruit at Cape Town," while a second report was issued in 1921 in conjunction with three members of his staff entitled "Further Investigation into the Cause of Wastage of Citrus Fruits from South Africa." In 1925 a Low Temperature Laboratory at Cape Town was created as a result of his persistently stressing the need for research staff and equipment to investigate the engineering and biological problems involved in the precooling, transport and storage of fruit. From its inception to the time of his retirement, the Laboratory enjoyed his personal interest and support.

For some years he had advocated a comprehensive botanical survey of South Africa. The objectives and advantages of such a survey were eventually brought directly to the notice of the then Prime Minister, General Botha, with the result that the Minister for Agriculture, in July 1918, approved of an Advisory Committee for Botanical Survey with the Chief of the Division of Botany and Plant Pathology as Director of the Survey. The Advisory Committee included the following prominent botanists, in an honorary capacity, to co-ordinate botanical research in the various parts of the country: Mrs. L. Bolus and Dr. R. Marloth of Cape Town, Prof. S. Schonland of Grahamstown, Prof. J. W. Bews of Pietermaritzburg, and Prof. G. Potts of Bloemfontein. Also nominated to serve on the Committee were Sir Arnold Theiler, Director of Veterinary Research, and Mr. C. E. Legat, Conservator of Forests. One of the most important aims of the Survey was to publish local floras, memoirs and handbooks dealing with the vegetation. The first memoir was published in 1919 and the series still continues to this day.

Pole Evans, who travelled widely throughout South Africa recording and photographing the major types of vegetation, published a preliminary account of his observations in 1917 in the official Yearbook of the Union of South Africa, in an article entitled "The Plant Geography of South Africa," with an accompanying map in colour. Later, as President of the South African Association for the Advancement of Science in 1920, he enlarged on the subject in his presidential address: "The Veld, its Resources and Dangers," which was published in the South African Journal of Science 17 : 1 — 34 (1920). In this paper he classified the country into 19 botanical regions and gave a brief ecological characterisation of each region.

In 1920 the first part of "The Flowering Plants of South Africa," a serial magazine based on hand-coloured illustrations, was issued under his editorship. The Government sanctioned the publication on condition that the necessary funds for the cost of publication were met by private subscription. With confidence in the succees of the venture, Pole Evans raised enough money through personal contact with liberal donors in South Africa and overseas to continue the work for many years. In 1946, some years after his retirement, the title was changed to "The Flowering Plants of Africa" and, from 1948, the Government has assumed full responsibility for its publication both in English and Afrikaans.

Another periodical, intended primarily as a medium for the publication of botanical papers and monographs emanating from the National Herbarium, was initiated by Pole Evans in 1921. He named the official organ of the Division *Bothalia* to commemorate General Louis Botha, first Prime Minister of the Union of South Africa and Minister of Agriculture until 1913, to whose policy and influence much of the rapid agricultural development in South Africa after Union was due.

The field of research under the direction of Pole Evans was enlarged in 1927 to include the Divisions of Entomology and Horticulture and, with the inclusion of a Field Husbandry section in 1929, the title of the organisation was changed to the Division of Plant Industry. In addition to its extensive research programme, this Division was responsible for regulations dealing with plant imports and quarantine, locust control, veld conservation, nursery inspection and the transport of perishable products.

His interest in the natural vegetation led to the establishment of the Dongola Botanical Reserve in the dry bushveld of the northern Transvaal. Here some of the finest examples of baobabs *(Adansonia digitata)* were to be seen. Unfortunately the Reserve was abandoned after his retirement. In 1926 the Veld Reserve at Fauresmith in the Orange Free State was initiated for the scientific study of indigenous grasses and bushes of the Karoo region. With the establishment of an up to date laboratory at this centre and the appointment of Dr. Marguerite Henrici, a series of valuable publications on the physiology and nutritional value of these plants was made possible. Further research centres were developed for the introduction and study of indigenous grasses at Prinshof and Rietondale in Pretoria, and for subtropical horticultural crops at Nelspruit in the eastern Transvaal.

He had for many years supported and taken a prominent part in associations devoted to science. In 1905 he joined the S.A. Ornithologist's Union, later to be amalgamated with the Transvaal Biological Society, of which he was a foundation member and President in 1911. The title of the Society was later changed to the S.A. Biological Society and he continued as a council member, receiving the Scott Memorial Medal in 1919, awarded by the Society for his research contributions. In 1907 he was elected a Fellow of the Linnaean Society (London) and became a member of the S.A. Philosophical Society, later to become the Royal Society of South Africa, and of this Society also he was a Fellow. He was a strong supporter of the South African Association for the Advancement of Science, becoming President of Section C in 1916 and, as mentioned previously, of the Association as a whole in 1920. In 1922 the Association awarded him the South African Medal and Grant for outstanding scientific achievements. The C.M.G. was conferred upon him in 1921 and, in 1933, the University of the Witwatersrand awarded him an honorary LL.D. degree.

On the occasion of the visit of the British Association for the Advancement of Science to South Africa in 1929, a handbook entitled "Science in South Africa"

was published in which the chapter on "Vegetation of South Africa" with an accompanying map was contributed by Pole Evans. This was the fore-runner of the well-known vegetation map on the scale of 1 : 3,000,000, published as Botanical Survey Memoir No. 15 (1936).

He was a member of the Editorial Board of the Empire Journal of Experimental Agriculture. In Vol. 1 (1933) of the Journal he wrote on "Agricultural Possibilities of Some of the African Grasses" and later, in Vol. 18 (1950), on "The Possibilities of Beef Production in Southern Africa." In 1935 he attended the Imperial Botanical Conference held in London, where he read a paper entitled "Pasture Research in the Union of South Africa," which was published in 1936.

In 1934 the House of Assembly expressed concern at the serious deterioration of the natural vegetation cover and the threat to the country's water resources caused by indiscriminate veld burning on the mountains. A programme submitted by Pole Evans was adopted as a basis for immediate action and this included the formation of a Pasture Research and Veld Management Section within the Division of Plant Industry. A series of Pasture Research Stations was established in representative vegetation regions in the Transvaal, Natal and the Cape Province in order to formulate sound principles of veld management.

This was the final official project he was to launch before his retirement in September 1939. In July 1939, in the preface to the bulletin entitled "Pasture Research in South Africa, Progress Report No. 2," he wrote that: "Grass is the foundation of man's existence in our land as in all others. It is surprising therefore that there should be any who are slow to recognize this and some even loth to admit it." "It is my obvious duty again to draw your attention to the fact that large areas of the country which formerly were rich and flourishing pastoral grounds are now wholly depleted of their grazing and are rapidly becoming desert wastes. Nothing but the establishment of well-equipped pasture research stations in these areas can bring any permanent relief and restore health to the land and wealth to the people." "To a small body of men and women under Dr. J. W. Rowland's able direction, credit must be given for lifting the veil that has so long obscured the dangerous trend of South African agriculture. Few thought that pasture research could be of much benefit to the Country as a whole and many begrudged the little that was spent on it in comparison with other State services. Yet, it has remained for pasture research to point out our folly in the past and to indicate safer and sounder methods of approach for the future."

South Africa owes a debt of gratitude to Pole Evans for his farsightedness and drive in building up a large and active body of research workers who were inspired by his own dedication and energy. One of his most important contributions was in stressing the value of the indigenous plant cover, and of grasses in particular, in conserving soil. His search for grasses suitable for grazing and conservation purposes took him beyond the borders of South Africa. Several visits were paid to Botswana and his travels in this territory are recounted in Botanical Survey Memoir No. 21 (1948). In 1938, at the request of the Kenya Government for his advice with regard to soil erosion and pasture problems, he undertook his most extensive expedition, travelling a distance of 13,000 miles through tropical Africa, and collecting over 700 living grasses, a large number of seed samples and nearly 2,000 botanical specimens. This expedition is described with numerous illustrations in Botanical Survey Memoir No. 22 (1948).

In 1922 he married Miss Mary R. H. Thomson B.A. (Cape) M.Sc. (Lond.), who had joined his staff as Mycologist in 1919, and who fully shared his wide botanical interests. Mainly due to her untiring devotion, he was able to accomplish

his many undertakings. After his marriage he made his home at Irene, some miles south of Pretoria and near Doornkloof, the home farm of his friend General Smuts. A keen horticulturalist, he introduced many indigenous plants into his garden. In the early 1950's he settled near Umtali in Rhodesia and continued to collect interesting indigenous plants in the surrounding area for several years until confined to his home through indifferent health.

Though sadly hampered by infirmity during his last few years and no longer able to walk, he retained his interest in natural history and enjoyed particularly the bird life in the beautiful garden he had created. He is survived by his widow and two children: Dr. Jean Pole Evans and Mr. Reginald J. Pole Evans M.B.E.

Many plants which he collected proved to be new to science and several commemorate his name, for example, *Aloe pole-evansii* Christian, *Gladiolus pole-evansii* Verdoorn and a fungus, *Puccinia pole-evansii* Doidge. In view of his interest in grasses, it is fitting that a grass he discovered in the mountains of Lesotho should be given the generic name *Polevansia* De Winter in his honour.

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Cultural Characters and Carpophore Construction of Some Poroid Hymenomycetes*

by

G. C. A. van der Westhuizen†

Abstract

The cultural characters and construction of the carpophores of 24 species of poroid Hymenomycetes were studied. The microstructures formed in culture and oxidase reactions of the cultures were compared with the microstructures present, the construction and type of decay of the carpophores from which they were made. The type of interfertility of seven species was determined.

Intercollection pairings of haploid mycelia derived from single basidiospores and the technique of dikaryotizing a large haploid mycelium growing in culture by pairing it with a small dikaryotic mycelium, were used to confirm the identity of different collections of eight different species.

The literature on the classification, structure and anatomy of the carpophores and pure culture studies of Hymenomycetes, was reviewed.

It was found that the 24 species were distributed among nine of the groups proposed by Nobles (1958) on the basis of their cultural characters. The structures formed in culture were also found to be present in the carpophores so that the carpophores could also be assigned to the some groups as their cultures. The carpophores did not indicate the same relationships as the cultures however. Differences in the micromorphological characters of hyphae and in the types of hyphae present in carpophores of species in the same group were found. Differences in construction of the carpophores were noticed in species with similar types of hyphae. Micromorphological characters of hyphae and the microstructures as well as the construction of the carpophores are constant for each species. Differences and similarity of micromorphological characters and construction of carpophores of different species are not adequately conveyed by the concept of hyphal systems.

All seven species tested displayed the tetrapolar type of interfertility. Six of these are associated with white rots. In the intercollection pairings, dikaryotization and clamp-formation of the haploid test mycelium could not be achieved with *Polyporus dichrous* and *Polyporus pubescens*.

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1. INTRODUCTION

The increasing use of timber and the afforestation of new regions of South Africa necessitates the detection and control of factors that cause losses of trees and timber. The recognition and identification of fungi which cause diseases of living trees and decay of timber, are important in this respect.

Identification of decay fungi, most of which are placed in the Hymenomycetes, poses many problems however. The fruit-bodies which are required for identification of a causal organism may be lacking or they may be abnormal or in a state in which they can not be identified with certainty. In many cases the wood-decaying fungus may be isolated in pure culture but this is no assurance that the fungus will be identified unless it is one of the relatively small number of species of which the characters in pure culture have been described. The characters of cultures of many wood-rotting Hymenomycetes can not be related to the existing descriptions of their carpophores. There is as yet no correlation between generic characters of fruit-bodies and cultural characters. Identification of these wood-rotting fungi from culture must go directly to the species. Studies relating cultural characters to characters of the carpophores from which cultures were made, thus need to be undertaken.

Most of the known species of Hymenomycetes in South Africa have been described by a number of older workers, listed by Doidge (1950), around the turn of the century. Later, Van der Bijl (1922 a, b, c; 1924; 1925; 1926) described a number of poroid Hymenomycetes but most of these descriptions are based on gross morphological characters. Not many of these descriptions include details of spore characters. Since morphological characters are known to be variable, it is often difficult to identify specimens with the aid of such descriptions. More precise descriptions are thus required.

The South African fungal flora includes a wide range of species, some of which are known from the cool temperate regions of the Northern Hemisphere, while others are truly subtropical or tropical species. The relationships between these taxa are, in most cases, unknown. Most of the generic type species have been described from the cool temperate regions where a number of systems of classification of the poroid Hymenomycetes were also developed. It is thus necessary to compare the taxa from the warmer regions with these generic types in order to determine their generic affinities as well as their relationships with other species in the same genera. Only in this way can a natural system of

classification of these fungi be developed. This need was also emphasized by Lowe (1963 a) recently.

Attempts to recognize relationships between species of poroid Hymenomycetes are of little value unless anatomical characters are taken into consideration. This view had been emphasized by the work of Corner (1932 a, b, 1947, 1948, 1950, 1953), Cunningham (1946, 1947, 1948 a-h, 1949 a, b, 1950 a, b, 1954, 1963), Pinto-Lopes (1952), Nobles (1956, 1958 b, 1965, 1967), Bondartzeva (1961, 1963) and Teixeira (1958, 1960, 1962 a,b). These workers have shown that the microscopic characters of the hymenial structures and hyphae that make up the carpophore, are more constant and reliable than the largely morphological criteria that have been used hitherto. Only Cunningham (1946, 1947, 1948 a-h, 1949 a,b, 1950 a, 1963) and Pinto-Lopes (1952) have proposed systems of classification of the Polyporaceae, based on their anatomical characters. These systems were however not generally accepted by students of this group. Nobles (1958 b) grouped cultures of 225 species of Polyporaceae on the basis of their biochemical activities, hyphal modifications and spore shape into 36 groups which she suggested to be natural taxa of generic or higher rank. This concept was favourably received by Bondartzeva (1961) and others as a new approach to the problem of polypore taxonomy, with great promise for the development of a natural system of classification of these fungi. Nobles' thesis however, is based on cultural characters where many hyphal modifications are known which have never been described from carpophores. It is thus necessary to undertake correlative studies of the cultures and carpophores in order to determine whether the structures found in culture are also present in the carpophores. Correlative studies which reveal the presence of identical vegetative structures in both carpophores and cultures should thus indicate relationships between carpophores similar to those indicated by cultural characters.

In some of Nobles' (1958 b) groups, however, species are included which differ widely in habit and morphology of their fruit-bodies although the cultures showed them to be similar in regard to hyphal morphology, spore shape and biochemical activity. Corner (1953) showed that certain species which may show superficial resemblances, may differ widely in the types of hyphae present as well as the arrangement of the hyphae or in the construction of the carpophores. It thus appears that together with hyphal morphology, the construction of the fruit-body must also be taken into account when considering relationships between different species of polypores. Although it has been known since the publication of Corner's (1932 a, b) classical papers that different types of hyphae are present in carpophores of poroid Hymenomycetes, relatively few serious attempts have been made to study these characters and apply these concepts to the solution of taxonomic problems. Studies in which cultural characters are correlated with the characters of hyphae and other microstructures and the construction of the carpophores of as many species of poroid Hymenomycetes as possible, should therefore provide the information which should make a natural system of classification of these fungi possible.

The present study was undertaken as a basis for future taxonomic work on the South African species of poroid Hymenomycetes. No taxonomic study had been undertaken on the South African polypores since the time of Van der Bijl (1922 a, b, c, 1924, 1925, 1926) and it has become necessary to apply modern techniques and concepts to the study of these fungi.

For this purpose a number of species were collected at random to obtain species with diverse characters and affinities. The cultural characters and carpophore characters of these species were studied to determine: (i) how Nobles'

(1958 b) concepts may be applied to them; (ii) whether the structures formed in their cultures are also present in their carpophores; (iii) whether the phylogenetic relationships indicated by their cultures also exist between the carpophores; (iv) to compare the cultural and carpophore characters of these species with these characters of other species, especially generic type species, in order to obtain possible indications of their phylogenetic affinities. In this way it was hoped to provide accurate descriptions of a number of common species to serve as a sound basis for future taxonomic studies of these fungi.

It has been shown by Davidson, Campbell & Blaisdell (1938), Overholts (1953), Nobles (1958 b) and Bondartzeva (1961) that the oxidase reaction of cultures of polypores, the type of decay caused by these fungi and their host preferences, are valuable characters for the identification of species and may also be of considerable taxonomic importance. The oxidase reactions of the fungi included in this study, were thus determined and their type of decay and host range recorded for these reasons.

Work by Vandendries (1922, 1923, 1924 and 1933), Mounce & Macrae (1936, 1937, 1938), Nobles (1943, 1967) and Boidin & des Pomeys (1961), among others, has shown that pairings between mycelia grown from single basidiospores may yield valuable information on the identity of morphologically similar fungi even when collected in different parts of the world. Nobles (1958 b) also advanced the thesis that species of the Polyporaceae causing brown rots, have the bipolar type of interfertility whilst species with simple clamp connections which cause white rots, have the tetrapolar type of interfertility. Where possible, single basidiospore cultures were thus prepared from the different South African species in order to determine whether this also applied to the South African species. It was also attempted to pair single basidiospore mycelia from South African collections with cultures of Canadian origin in order to confirm the identity of different collections whenever possible.

As this study was intended as an exploration of the usefulness of the modern techniques in the taxonomy of South African polypores, no attempt was made to determine the full synonymy of the different species. Instead, only generic synonyms are cited and the species are described under their basinyms or their more generally used binomials. No new combinations or genera were made or created and possible phylogenetic relationships are merely indicated in the descriptions.

2. REVIEW OF LITERATURE

Classification of the poroid Hymenomycetes

In his early classification of the pore fungi, Fries (1821) recognized five genera, viz. *Daedalea, Polyporus, Merulius, Boletus* and *Fistulina* of which the last three are not considered to be genera of the Polyporaceae by most workers today. The generic distinctions were based on hymenial configuration but this soon proved to be inadequate. In later works, Fries (1828, 1838, 1874) added new genera or accepted genera proposed by other workers until, in 1874, he recognized eight genera of Polyporaceae and seven others in which the hymenium is borne in tube-like structures. Hymenial configuration and gross morphological characters such as the nature of the surface of the carpophore, were the basis of these generic concepts. Other workers soon added more genera in recognition of the desirability of splitting up Fries' unwieldy and heterogeneous groups into smaller

more natural ones. Among the first workers in this respect were S. F. Gray (1821) who added nine genera and Quelét (1886) who listed the polypores of France under 15 genera, ten of which were new. Karsten (1880, 1881, 1889) split Fries' genera *Polyporus* and *Daedalea*, into 26 different genera most of which are considered to be acceptable genera today. Murrill (1907 b, 1908), recognized 74 genera of Polyporaceae, which he divided into 4 sub-families on the basis of habit and hymenial configuration of the carpophore. The basis for segregation of the genera, was partly gross morphological characters and to a lesser extent, anatomical characters, mainly spore characters. Lloyd (1898, 1905, 1909, 1913, 1916, 1920, 1922) in his Mycological Writings on the other hand recognized only 12 genera in the Polyporaceae. The basis for these was mainly gross morphological characters. Anatomical characters were considered to be of value at the species level only.

Van der Bijl (1922 a, b, c, 1924, 1925, 1926) published descriptions of the South African species of polypores during this period. Morphological characters were the basis for this work in which anatomical details are often lacking. The generic concepts in this work were those of Fries (1838, 1874) and Lloyd (1898-1925). Only 8 genera were recognized and distinguished on the basis of hymenial configuration and pore shape, method of attachment of the carpophore and consistency of the pileus. The resupinate forms included in the genus *Poria*, were omitted. More recent works on Polyporaceae by Overholts (1953), Lowe (1946, 1947, 1948, 1957, 1958, 1963 b, 1966), Lowe & Gilbertson (1961 a, b) and Gilbertson (1961) are still based on the generic concepts of Fries (1821, 1838, 1874) although many micromorphological characters are included in their descriptions of species.

The trend to delimit genera on the basis of micromorphological characters was initiated by Patouillard (1887) who recognized 39 genera delimited on the basis of microscopic and morphological characters (Patouillard, 1900). These concepts were later applied and extended by other workers, namely Carlton Rea (1922), Bourdot & Galzin (1928), Donk (1933), Pilát (1936), Imazeki (1943), Bondartzev & Singer (1941), and Bondartzev (1953) to the polypore floras of their respective countries. Among these workers a tendency towards recognizing an increasing number of genera in the polypores is clearly evident ranging from 10 genera in the British Isles (Rea, 1922) to 61 genera in the European part of the U.S.S.R. (Bondartzev, 1953).

Systems of classification of the Polyporaceae in which the micromorphology of the hyphae or the concept of hyphal systems as advanced by Corner (1932 a, b) were used to characterize genera, were proposed by Cunningham (1946, 1947, 1948 a-h, 1949 a, b, 1950 a) and Kotlaba & Pouzar (1957). Cunningham (1946, 1947, 1948 a-h, 1949 a, b, 1950 a) applied these concepts of hyphal systems to his studies of the Polyporaceae of New Zealand in which he recognized only 12 genera.

Pinto-Lopes (1952) regarded Corner's (1932 a, b) and Cunningham's (1947, 1948 a-h, 1949 a, b, 1950 a) concepts and application of hyphal systems to be of little value. He instead regarded the type of septation and thickening of the walls of hyphae as the only criteria of taxonomic value. On this basis he proposed a system of classification of the Polyporaceae in which he recognized 22 genera divided among seven sub-families.

Kotlaba & Pouzar (1957) proposed a system of classification of polypores of Czechoslovakia based on hyphal systems in which they recognized 48 genera, seven of which were new. Most of their concepts were based on the work of Cunningham (1946, 1947, 1948 a-h, 1949 a, b, 1950 a) and Teston (1953 a, b).

Bondartzeva (1961) critically reviewed the more recent systems of classification of the polypores. She rejected the systems of Cunningham (1947, 1948 a-h, 1949 a, b, 1950 a) and Pinto-Lopes (1953) as artificial and instead regarded that of Kotlaba & Pouzar (1957) as more natural but incomplete. In her opinion the system of Bondartsev & Singer (1941), which was later adopted with certain modifications by Bondartzev (1953), is the most natural one since it considers structure or texture in relation to anatomy and morphology of the fungi.

It is evident that the basis for classification of the poroid Hymenomycetes have undergone profound changes since Fries (1821) published his system. It is also evident that there is an almost total lack of agreement on generic concepts in these fungi. These different systems of classification and generic concepts had been reviewed by Cooke (1959) who listed about 300 genera which had been proposed for the Polyporaceae. He considered about 100 of these to be valid and usable.

Donk (1960, 1962) discussed the origin, usage and status of the generic names proposed for polypores and agreed with Cooke (1959) in many respects. Later, in his conspectus of the families of the Aphyllophorales, Donk (1964) recognized the impossibility of including in the family Polyporaceae, genera of which the characters had not been clearly defined. Consequently the Polyporaceae were not discussed in full in that work.

Despite this confusion two main trends are noticeable in a survey of these works, viz.: (i) a tendency toward the recognition of a larger number of genera of poroid Hymenomycetes and (ii) a change in the relative importance of the taxonomic criteria away from the macroscopic morphological characters of the older taxonomists towards the micromorphological and anatomical characters considered to be more important by the modern workers. This must mean that there is a growing conviction among mycologists that the micromorphological characters are more constant and reliable in taxonomic studies than the macroscopic characters and therefore more capable of indicating phylogentic relationships. This in turn would allow the grouping of species and consequently more precise generic deliminations.

It must be emphasized however that most of the systems of classification and generic concepts proposed so far, were based on species found in the cool temperate regions of the Northern Hemisphere. Very few tropical or sub-tropical species, of which many occur in South Africa, have been described or included in these classifications. This shortcoming was recognized by Lowe (1963 a) when he stated: "I have been and will for some time be preoccupied with species concepts. Until these are cleared up for a large proportion of the polypores particularly the tropical species, I cannot consider, without crippling misgivings, the larger aspects of generic separations." The accurate description of micromorphological characters of the hyphae and other microstructures in fruit-bodies is thus of the greatest importance in the taxonomy of these fungi.

Structure and Anatomy of the Carpophore in Taxonomy

The first important work on the taxonomic value of micro-structures and anatomy was published by Patouillard (1887) who included details of hyphal morphology, structure of the surface of the pileus and characters of basidia, spores and cystidia, in his generic descriptions. Later he used these characters to delimit genera of the Hymenomycetes (Patouillard, 1900).

Ames (1913) studied structure of the fruit-bodies in relation to generic concepts of 130 North American species. She considered anatomical features such as consistency and hyphal arrangement of the trama, modifications of the surface of the pileus, the relation of the hymenophore to the pileus and spore characters, to be of great taxonomic value. Characters of the cystidia were regarded as too variable to be of any value above the species level while spore colour was regarded as the most important spore character and preferable to context colour as a criterion for generic delimitation. Ames concluded that the character of the flesh or the consistency of the fruit-body indicate the broader relationships within the Polyporaceae most clearly but that in the recognition of genera a complex of characters rather than separate characters must be considered. On the basis of her studies, which did not include the resupinate species, she recognized 16 genera among the temperate North American species.

The great advance in the study of micromorphology of basidiomycete carpophores was made possible by the work of Corner (1932 a, b) who introduced the concept of hyphal systems. He demonstrated that the fruit-body of *Polyporus xanthopus* (Corner, 1932 a) is constructed of three types of hyphae which differ morphologically in respect of type of septation, wall-thickness, morphology, ontogeny and function. The generative hyphae are hyaline, thin-walled and nodose-septate and are the basic hyphae from which all other hyphae as well as the basidia are produced. The skeletal hyphae are thick-walled, unbranched and aseptate and form the main structural elements of the pileus. They arise from lateral branches of the generative hyphae. The binding hyphae are thick-walled and aseptate and also arise from generative hyphae but are of limited growth and have many short, tortuous branches which bind the other hyphae into the tough, leathery tissues of the pileus. These three types of hyphae thus constitute a fruit-body with a trimitic hyphal system. The fruit-body of *Fomes laevigatus* (Corner, 1932 b) on the other hand consists only of thin-walled, simple-septate generative hyphae and thick-walled, aseptate, unbranched, skeletal hyphae. Because the binding system is lacking, the fruit-body of *Fomes laevigatus* has a dimitic hyphal system. The term "monomitic hyphal system" was proposed to describe the construction of fruit-bodies in which only generative hyphae are present. Later, Corner (1953) showed that certain species have fruit-bodies with dimitic hyphal systems which consist of generative and binding hyphae. *Asterodon* spp. and *Asterostromella* spp. (Corner, 1948) were shown to have other specialised structures in their dimitic fruit-bodies, which are similar to structures found in the fruit-bodies of *Aleurodiscus* spp., *Hymenochaete* spp. and *Fomes spp*. But Corner regarded the elaborate fruit-body of *Polystictus xanthopus,* with trimitic hyphal system, as more highly evolved than the dimitic or monomitic types (1932 b). He showed that differences in colour and texture of fruit-bodies are determined by the characters of the crust and hyphal systems while the microscopic structure of the upper surface determines whether it will be smooth, mat, velutinate, tomentose, laccate and so forth (Corner, 1932 a, b; 1953).

Corner (1950) used the concepts of hyphal systems as well as other microscopic characters to delimit genera in a monographic treatment of the clavarioid fungi and later of the cantharelloid fungi (Corner, 1966).

Corner thus showed that thin-walled, septate hyphae are present together with other hyphae, modified in various ways, in the tissue of fruit-bodies of Hymenomycetes. He further demonstrated the interrelationships of these different kinds of hyphae and showed that the consistency of the tissues and the nature of the upper surface depend on the nature of the hyphae present in the fruit-body. He also indicated the phylogenetic significance of the different kinds of hyphae and their possible use in the classification of these fungi.

Humphrey & Leus (1931) made anatomical studies of the upper surfaces of the pilei of *Ganoderma* spp. They found that there were anatomical differences in the surfaces of these species and that these anatomical characters were constant for each species.

K. Lohwag (1940) made anatomical and morphological studies of the upper surfaces of a number of European fungi. Many of these were type species of genera which had been proposed by various European workers at different times. Lohwag distinguished five main types of covering of the pilei, viz.:

1. The derm which consist of hyphae which run more or less perpendicular to the surface. Of this, there are three kinds, (a) the *hymeniderm* in which the elements are tightly packed, resembling a hymenium; (b) the *trichoderm* consisting of hair-like elements, either separate or bundled together, and closely joined and, (c) the *palisadoderm* similar to the hymeniderm but consisting of slender, loose elements.
2. The hymenophoral cover, which consists of a sterile hymenophore.
3. The cutis, which consists of elements arranged parallel to the surface giving the smooth glabrous appearance.
4. The cortex which consists of a denser matting of more or less modified hyphae of the context.
5. The crust, which consists of a hard and sharply distinguished layer on the surface without regard to its structural origin.

Later, H. Lohwag (1941) adopted K. Lohwag's terminology in his studies on the anatomy of the Asco- and Basidiomycetes and introduced the term paraderm to describe the surface covering which consists of a pseudo-parenchymatic structure built up of isodiametric cells.

Furtado (1965 a), in his studies of the relation of the microstructures to the taxonomy of the Ganodermoideae, reformulated the older concepts of the types of structure of the pilear cover in more exact terms. He also introduced the terms "lacca-like substance" and "laccate appearance" to replace "lacca" and "laccate", as previously used by many authors, because the chemical nature of this substance is unknown. He regarded the "cortex" and "derm" as the two major categories of structures found in the Ganodermoideae. The term "cortex" he applied to "a structure lacking any distinctive layer" but characterized by a "continuous and progressive condensation of the context hyphae towards the periphery." The "derm" was defined as "all types of structures in which the hyphae are anti-clineal to the pilear surface." Five types of derm, viz., the Hymeniderm, Palisadoderm, Trichoderm, Paraderm and Indeterminate derm, were recognized. The first four terms agreed with those of K. Lohwag (1940) and H. Lohwag (1941) while the fifth was proposed for "the type of derm found in a structure formed of incrusted and intermingled hyphae in which the original arrangement cannot be traced precisely." These studies clearly demonstrated the varied nature of the upper surface and the morphological differences that exist between the hyphae that comprise the various types of covering of the pileus. The proposed terms, however, do not indicate which type of hyphae, if more than one type of hypha is present in the pileus, undergo the modifications to produce a specific kind of upper surface.

After publication of Corner's concepts of hyphal systems (1932 a, b) and Lohwag's (1940) work on the nature of the upper surface of fruit-bodies several workers realized the potential usefulness of these concepts in Hymenomycete taxonomy and called for urgent application of Corner's methods to studies of

Hymenomycetes. Corner (1954) a) stated that only by a study of hyphal characters could a natural system of classification of the Hymenomycetes be worked out. Both Corner (1954) a) and Wakefield (1948) mentioned the existence of series of Hymenomycetes related by structure but differing in hymenial configuration and characters. They stressed the importance of separating species and genera by considering the sum of all the characters present in the carpophore. Kotlaba (1964) restated the views that the microstructures of carpophores and spore characters are the only constant and reliable characters in Hymenomycete taxonomy. He stated: "The importance of these characters lie in their particular combinations. Furthermore, the same character may have different taxonomic value in different groups and cannot be generalized." He thought that genera of higher fungi should be delimited on the basis of a complex of characters while species may be delimited on single characters only.

Cunningham (1946, 1947, 1948 a, b, c, d, e, f, g, h, 1949 b, 1950 a, 1954) was the first worker to apply Corner's concept of hyphal systems to the classification of polypores. In his studies of the Polyporaceae of New Zealand, in which he recognized 17 genera, he regarded the types of hyphal systems present in the fruit-bodies, together with the absence or presence of clamps on the generative hyphae, the colour of the hyphae and the type of basidia produced, as important at the generic level. These criteria, however, were not used consistently. While some genera were characterized by the absence of clamp connections, e.g. *Fomes* Kickx, *Fomitopsis* Karsten, *Coltricia* Mich. ex S. F. Gray and *Inonotus* Karst., species both with and without clamp connections were left in *Poria* and *Merulius* Hall. ex Fr. Similarly, he included in some genera, e.g. *Lenzites* Fr., *Trametes* Fr., *Coriolus Quél.* and *Daedalea* Fr., only species with trimitic hyphal systems while species with monomitic, dimitic, and trimitic hyphal systems were included in *Poria*. This inconsistency is perhaps not surprising since a study of Cunningham's (1946, 1954) definitions of the different types of hyphae, do not reveal distinct and constant differences between skeletal and binding hyphae. It appears that Cunningham himself was not too clear about differences between these types of hyphae.

Pinto-Lopes (1952) also proposed a system of classification of the Polyporaceae based mostly on the characters of the hyphae which comprise the fruit-body. In a bio-taxonomic study of polypores, he concluded that the characters of the hyphae were fixed and genetically constant under many different conditions of growth in the carpophores as well as in culture on artificial media. He distinguished between three types of hyphae, viz. primary, secondary and tertiary. Hyphae produced by germinating basidiospores are primary hyphae but they become secondary hyphae, which may form clamp connections, after fusion with other genetically compatible primary hyphae. Differentiated hyphae, which are characterized by thickening of the wall, are the tertiary hyphae. According to him the carpophores of all species consist of secondary and tertiary hyphae of which the micromorphological characters are constant. In order to prove the constant characters of the tramal hyphae, he also investigated those characters in artificial culture and found that: (i) secondary and tertiary mycelium were always present in cultures although it was difficult to distinguish the tertiary mycelium in some cases; (2) species with clamp connections on the secondary hyphae of the carpophore also have them on the secondary hyphae in culture; (3) with some exceptions, the colour of the mycelium in culture was the same as that of the hyphae of the carpophore and was produced in the same way. He concluded that the same types of hyphae are present in both carpophores and cultures. Pinto-Lopes concluded that each species has a plan of anatomical organization which is always constant in all carpophores and that carpophores of the same species always have

the same structure in spite of differences in the appearance of the upper surface of the carpophores. Hyphal characters have great taxonomic value while characters such as surface of the carpophore and consistency of the context are of lesser value. Macroscopic characters such as carpophore shape, pore shape, tube length and microscopic characters such as spore shape and spore colour he regarded as having no taxonomic value. He agreed with Ames (1913) that certain microscopic structures such as cystidia are useful aids for the recognition of species but are too variable to be of taxonomic importance above this level. Pinto-Lopes regarded the characters of the secondary hyphae as of prime value and the characters of tertiary hyphae of secondary value but the characters of the secondary and tertiary hyphae taken together are of prime value and permit the division of the family into sub-families On this basis he distinguished eight main groups in the Polyporaceae with the following hyphal characters:—

A. Secondary hyphae with clamp connections:
   (1) tertiary hyphae hyaline, with clamp connections and walls not thickened or slightly thickened;
   (2) tertiary hyphae hyaline, with clamp connections, walls thickened;
   (3) tertiary hyphae hyaline without clamp connections, walls more or less thickened, and
   (4) tertiary hyphae yellow or brown, without clamp connections and walls more or less thickened.

B. Secondary hyphae without clamp connections:
   (1) tertiary hyphae hyaline, septate and walls slightly thickened;
   (2) tertiary hyphae yellow, septate, and walls slightly thickened;
   (3) tertiary hyphae hyaline, aseptate, walls much thickened, and
   (4) tertiary hyphae yellow or brown, aseptate and walls much thickened.

These distinctions formed the basis for his system of classification of the Polyporaceae consisting of 22 genera distributed among 7 sub-families.

The work was severely criticized by Corner (1954 b) for the author's views on hyphal modifications and his disregard for characters other than those of the hyphae. His lack of close adherence to the International Code of Botanical Nomenclature also drew criticism (Cooke, 1959; Teixiera, 1962 b) and the work did not meet with acceptance among mycologists. Nevertheless, Pinto-Lopes' work is of considerable value because of the accurate and reliable observations on the hyphal characters of the species described and his confirmation of the existence of different types of hyphae in the fruit-bodies of a large number of species of Polyporaceae. Despite its shortcomings, it cannot be disregarded by any student of micromorphology and taxonomy in the Polyporaceae.

Both Corner and Pinto-Lopes thus focussed the attention of taxonomists sharply on the varied nature of the microscopic characters of the hyphae in the carpophores and have indicated their value in the taxonomy of this group. Both workers have indicated the important differences between the undifferentiated and differentiated hyphae in fruit-bodies of Hymenomycetes.

The use of hyphal characters and Corner's (1932 a, b) concepts of hyphal systems have been applied to taxonomic studies of polypores by a number of different workers. Teston (1953 a) stated that Corner's (1932 a) and Cunningham's (1946) definitions of hyphal systems do not distinguish clearly between skeletal and binding hyphae. In her study of the hyphal systems of 100 species of Polyporaceae from the Bourdot herbarium in the Museum of Natural History

in Paris, Teston (1953 a, b) often found it difficult to place particular hyphae in one of the three systems and to decide whether a particular species was monomitic, dimitic or trimitic. She reported that thickened walls and lack of septa distinguish the skeletal systems from the generative system but that intermediate stages, i.e. hyphae with thickened walls and clamp connections can also be present. In less complex species, such intermediate hyphae, (mediate hyphal system, Corner, 1932 a) would be numerous and function as a pseudo-skeletal system. If species of each genus were arranged in order of decreasing importance of the pseudo-skeletal system, an almost continuous series is obtained in which it is difficult to separate clearly the monomitic species from the dimitic. In species where clamp connections are lacking on the generative hyphae, the distinction is even more difficult and can be based only on wall thickness which varies progressively. With regard to the binding hyphae, Teston (1953 a,b) believes that they cannot be defined absolutely, but only by comparison with the skeletal hyphae. Although distinctions exist in form and diameter and staining reactions, the binding and skeletal systems are related through a system of intermediates. Teston agreed with Cunningham (1946) and Pinto-Lopes (1952) that absence or presence of clamp connections is of great importance in relation to structure. Species which do not possess clamp connections on the generative hyphae do not attain the same complexity of structure which is found in species with clamp connections on their generative hyphae. She concluded that species can be arranged in order of increasing complexity, from monomitic species through all intermediates to trimitic species, within each genus. But the characters of differentiated hyphae cannot serve as a basis for taxonomy because it will lead to the fragmentation of genera. It is a badly defined character which may vary with size and age of the fruit-body. Only rarely does it permit the recognition and definition of natural groups. It can be used to advantage to arrange species in such groups.

Teston's (1953 a, b) observations thus indicate that the hyphal modifications are not as clearcut and fixed as Corner (1932 a, b, 1954), Cunningham (1946) and Pinto-Lopes (1952) believed. Teston's conclusions differ from these author's views that hyphal characters are of primary importance in the taxonomy of the Polyporaceae although she does admit that they may permit the recognition and definition of natural groups.

Hansen (1958) in her study of the anatomy of the Danish species of *Ganoderma*, confirmed some of Teston's (1953 a, b) observations and conclusions. Hansen found that the skeletal hyphae differed from Corner's (1932 a, b, 1953) definition in that they often have one or more branches near their distal ends. Their main stems are thick-walled and aseptate and arise at clamp-connections on thin-walled, generative hyphae. The lateral branches act as ties although the main stems are arranged longitudinally. In the dissepiments, these lateral branches of the skeletal hyphae take over the binding function completely. Binding hyphae are present in the context only and are of the bovista type. Hansen concluded that the differences in the skeletal systems of the species examined are of a qualitative as well as quantitative nature and not constant enough for use in the delimitation of species.

The American workers, Lowe and Overholts, on the other hand, largely ignored the concepts of hyphal systems in their work on American polypores. Overholts (1953) in his account of the Polyporaceae of the North-eastern United States and Canada, included details of spores, basidia, cystidia and other microstructures and hyphae in his descriptions of species. He often used the term "hyphal complexes" in descriptions of species which possess binding hyphae in Corner's (1932 a) terminology. No attempt was made to use these characters for generic delimitation or classification of the species described. Similar work was

published by Lowe (1946, 1947, 1948, 1956, 1957, 1958, 1961, 1963 b, 1966) who included details of characters of the spores, hyphae and other microstructures of the large number of species described by him. These characters were used for diagnostic purposes at the species level only while the generic concepts were Friesian.

Banerjee & Debi (1956) attempted to relate micromorphological and structural differences with morphological differences in the fruit-bodies of different collections of *Polystictus xanthopus*. They could distinguish three morphologically different types of fruit-body, viz.:

1. thin fruit-bodies with long, narrow, excentric stipes and minute, regular pores;
2. small, thick, fruit-bodies with thick, excentric stipes and regular but larger pore mouths, and
3. thin, sessile fruit-bodies with hydnoid to irpicoid pores.

Forms intermediate between all three types, were found. The basidia and spores of fruit-bodies of the first two types were similar in size and shape. The basidia of the third type of fruit-body were larger than those of the other two types and so were the spores, which also differed in shape. Fruit-bodies of the first two types consisted of generative hyphae with clamp connections and mediate hyphae, skeletal hyphae and binding hyphae. In fruit-bodies of the third type, no binding hyphae were present but only much branched generative hyphae which resembled binding hyphae. The authors described binding hyphae as much-branched, thick-walled, and without clamp connections. They concluded that two varieties of *Polystictus xanthopus* exist since "the separation into three types by macroscopic characters alone cannot be substantiated in all cases by microscopic characters and in other details." The larger pore, basidium and spore dimensions as well as the absence of binding hyphae, distinguish the third type of fruit-body from the other two. These workers thus did not regard these differences to be sufficiently important and constant to justify recognition of separate species.

Teixeira (1956, 1958, 1960, 1962 a, b) on the other hand firmly believes that the microstructures and hyphal morphology of the carpophores of polypores are the only characters of taxonomic value. Teixeira & Rogers (1955) noticed that *Aporpium caryae*, which has a poroid hymenial surface, also has cruciate-septate basidia. They transferred this species to the Tremellales which are characterized by such basidia. Teixeira (1956) published details of his methods of studying the construction of the carpophore. Essentially, these consist of carefully teasing apart thick sections, from different parts of the carpophore, cut parallel to the direction of growth of the hyphae and dissecting out individual hyphae with the aid of fine needles under 50x magnification of the dissecting microscope. The morphology of the hyphae and other microscopic structures and their inter-relationships, are then studied under the oil immersion lens. This method is essentially similar to that described by Corner (1932 a, b, 1953). Recently Fidalgo (1967), published a sophisticated method of obtaining intact hyphae for microscopic examination from carpophores by means of ultrasonic vibrations.

Teixeira (1958) applied his method to study the microstructure of *Laricifomes officinalis*. He showed that this fungus, which is the type species of the genus *Laricifomes* Kotlaba & Pouzar, differs in a number of structural details from *Fomes fomentarius* the type species of *Fomes* Kickx, (Donk, 1960). He also demonstrated (Teixeira, 1960) that the generative hyphae of a number of common North American species have clamp connections at the septa although this fact is not mentioned in a number of important reference works in this field. Clamp connections were absent from the generative hyphae of two of these species.

Teixeira (1926a) afterwards applied his method to the study of the microstructure of the basidiocarps of species of the genus *Fomes* Kickx. In this work he amended the generic description to include species of which the surface is covered by a definite crust over a chestnut-coloured context consisting of thin-walled, hyaline generative hyphae with clamp connections at the septa and thick-walled, differentiated hyphae without clamp connections, the skeletal and binding hyphae. The ends of the skeletal hyphae at the upper suface are agglutinated into the tough, hard crust. Hairs over the crust are produced by terminal proliferation of these skeletal hyphae. Although the skeletal hyphae are aseptate, generative hyphae with septa and clamp connections often produce branched structures which resemble the binding hyphae. Together with the type species *Fomes fomentarius*, two other species were recognized. Species were distinguished on the characters of the crust and the size of the pores. On the basis of this work, Teixeira concluded that the microstructures of the fruit-bodies, such as basidia, spores and other hymenial structures, as well as the nature of the generative hyphae and the specialised branches which they produce, are genetically constant in character and therefore more reliable in taxonomy than the morphological features which are still used to delimit genera in the Polyporaceae. These conclusions were restated and supported by numerous examples from earlier literature in a review of the taxonomy of the Polyporaceae published later (Teixeira, 1962 b).

O. Fidalgo & M. E. P. K. Fidalgo also used Teixeira's (1956) methods to study the hyphal systems and taxonomy of a number of genera and species of polypores. By these methods, M. E. P. K. Fidalgo (1958) demonstrated that *Lenzites cinnamomea* Fr. differs from *Gloeophyllum sepiarium* (Wulf. ex Fr.) Karst. in the characters of the skeletal and binding hyphae. She later proposed the genus *Phaeodaedalea* (M. E. P. K. Fidalgo, 1961) similar to *Gloeophyllum* Karst. and *Hexagona* Fr. in its trimitic hyphal system, but differing from these genera in having brown, globose spores. She also showed that *Trametes odoratus* Fr. is characterized by a dimitic hyphal system (M. E. P. K. Fidalgo 1962). The genus *Osmoporus* Sing., of which *Trametes odoratus* is the type is thus distinct from *Gloeophyllum* Karst. of which the type species, *Gloeophyllum sepiarium* (Wulf. ex Fr.) Karst., has a trimitic hyphal system.

O. Fidalgo (1958) concluded that *Ptychogaster rubescens* is the chlamydosporous form of *Polyporus guttulatus* Peck because of similarities between hyphae from cultures of *Polyporus guttulatus* and those from the fruit-bodies of *Ptychogaster rubescens*. Later, (O. Fidalgo 1962 a, b) he showed that *Bornetina corium* Mangin & Viala is the imperfect state of *Diacanthodes novoguinsensis* (P. Henn.) O. Fid. and that both are characterized by a monomitic hyphal system with clamp connections on the hyphae and a tendency to be dimitic.

In collaborative studies, Fidalgo & Fidalgo (1962) described the hyphal systems, the morphology and construction of the sporocarp of five species of polypores. They also proposed the new genus, *Pseudofistulina*, (Fidalgo & Fidalgo, 1963) for which extensive descriptions of the micromorphology of the hyphae and other structures, as well as descriptions of the construction of various parts of the fruit-body, were presented. This genus differs from *Fistulina* Bull. ex. Fr., as typified by *Fistulina hepatica* Huds. ex Fr., by the absence of clamp connections on the hyphae, the presence of a derm composed of acanthophyses and hyaline, thin-walled spores instead of yellow, thick-walled spores. Both genera have monomitic hyphal systems.

The presence or absence of clamp-connections on the hyphae of Hymenomycetes and their importance in taxonomy has been the subject of much discussion by various workers. Not much attention was given to these structures by Bourdot

& Galzin (1928), Donk (1933), Overholts (1953), and Lowe (1948, 1956, 1957, 1958, 1963 b) who often reported them to be absent from hyphae of species where they are now known to be present (Pinto-Lopes & Farinha, 1950). For taxonomic purposes, the presence or absence of clamp connections are regarded to be of value at the species level only by some workers such as Hesler & Smith (1963) and Smith (1966) while others, notably Pinto-Lopes (1952) Singer (1962) and Teixeira (1962 a, b) believe them to be of value at a higher level. The former view is supported by Smith's (1966) observations that clamp connections regularly occur only in a small number of species of some genera in the *Gasteromycetes*. Pantidou (1961), and Pantidou & Groves (1966) found that clamp connections were present in mycelium of species of Boletaceae grown in cultures but which do not have clamps on the hyphae of their fruit-bodies while in other species, clamp connections and simple septa were present in the same mycelium. Smith (1966) suggested that since the numbers of species with clamps vary in different groups, a quantitative study of the proportion of clamped septa in both clamped and clampless species is needed as well as mating compatibility studies between single spores of clamped and clampless species. Until such studies had been undertaken he regards the absence or presence of clamp connections on the hyphae of the basidiocarp as of significance at the specific level only. On the other hand the views of Pinto-Lopes (1952), Singer (1962) and Teixeira (1962 b) are supported by the work of Cunningham (1946, 1947, 1948 a-h, 1949 a, b, 1950 b), Teixeira (1958, 1960, 1962 a, b), O. Fidalgo (1958, 1963), M. E. P. K. Fidalgo (1961, 1962), Fidalgo & Fidalgo ((1962, 1963, 1966, 1967) and Furtado (1964, 1965 a, b, 1966, 1967) who found clamp connections to be constantly absent or present on the generative hyphae of different species of Polyporaceae, and who characterized genera on this basis. The position was well summarized by Singer (1962) who stated: "If the presence or absence of clamp connections is used as a character in taxonomy it is essential to make sure that the specimen studied is not merely a parthenogenetic form of a normally bipolar or tetrapolar species. If this possibility is excluded we have further to deal only with species with normal sexuality that have lost their ability to form clamp connections and homothallic forms, species or genera that find themselves in the same condition. Under these circumstances the presence or absence of clamp connections must be accepted as a valuable character." In Donk's (1964) recent treatment of the Aphyllophorales, it is evident that some groups contain species with clamp connections only while others contain species with simple septa only. Donk is of the opinion that "the value of clamps as a taxonomic feature differs from group to group and may even appear erratic within rather small taxa of lower rank such as species." Furtado (1966) pointed out that "in the clamped species studied experimentally, clamp connections are formed only in one specific heterokaryon, the dikaryon." He proposed that since clamp formation is controlled genetically, it is necessary to study the cytogenetic condition of the hyphae whenever the pattern of septation is decisive for definition of any taxa or the proposal of any hypothesis.

The concept of hyphal systems and the use of hyphal characters in taxonomic studies have also been applied to non-poroid Hymenomycetes. Ragab (1953) reported that most species of the Hydnaceae have monomitic hyphal systems while some are dimitic. In some genera monomitic as well as dimitic species are found. He included a key to 14 genera in the Hydnaceae, based on hyphal characters as well as morphology.

Cunningham (1963) applied his concepts of hyphal systems in studies of the Thelephoraceae of New Zealand. The hyphal systems were however used as a taxonomic character only at the generic or even sub-generic level. Cunningham (1963) attached greater importance to the microscopic structures of the hymenial

layer and differences in habit and hymenial configuration. Cunningham stated: "There is not the marked differentiation in hyphal systems in the Thelephoraceae that is so noticeable a feature of the Polyporaceae; far the greater number of genera possess species with both monomitic and dimitic systems, hyaline and brown hyphae and are with or without clamp connections. A few genera however do show some differentiation."

Talbot (1951, 1954 b, 1958 a, b) used micromorphological characters to delimit genera and species in his studies of the South African resupinate Hymenomycetes. In his descriptions, full details of hyphal characters and microscopic structures were included but the concept of hyphal systems is not always evident. He regarded the nature and absence or presence of microscopic structures in the hymenium as of greater taxonomic importance. In this respect he agreed with Cunningham (1963) and other workers.

Reid (1959, 1962, 1963, 1965) also placed much emphasis on micromorphological characters of hyphae and microscopic structures in his taxonomic studies which include mainly the lower Hymenomycetes.

Welden (1960), who revised the American species of *Cymatoderma* Jungh. on the basis of anatomical studies, could distinguish four main types of hyphae in the context of these fungi, viz.:

(1) long sub-solid to solid hyphae rarely branched or clamped, arising gradually or abruptly from thin-walled hyphae,

(2) similar but narrower and more tortuous hyphae,

(3) solid to sub-solid, narrow, short or long branching hyphae, and

(4) thin-walled, relatively wide branching and clamped hyphae.

Intermediates between these may also be found. Welden (1960) found that he could not apply Corner's (1932 a, b) terminology to the hyphae and hyphal structure despite the fact that Reid (1959) had divided the genus into dimitic and trimitic sections. Welden considered some of the branching hyphae to perform skeletal as well as binding functions while some of the thick-walled hyphae with clamp-connections served generative as well as skeletal functions. He concluded: "I do not wish to negate the useful terms 'dimitic' and 'trimitic,' but a strict interpretation of Corner's terms does not appear applicable to the American species of *Cymatoderma* unless all the species are considered trimitic". He used macroscopic morphological characters as well as microscopic characters of the hyphae and hymenial and sub-hymenial structures to delimit species.

Lentz (1960) made extensive use of micromorphological and hyphal characters to characterize type species of *Stereum* Pers. ex. S. F. Gray and allied genera after he realized that his earlier descriptions (Lentz, 1955) of the genus *Stereum* in the upper Mississippi Valley was based largely on macroscopic and gross microscopic characteristics.

Slysh (1960) used characters of the microscopic structures and hyphae of the fruit-bodies of *Peniophora* Cooke to describe the species found in New York State and surrounding regions. He reported that only one species, *Peniophora greschikii* is composed of two distinct types of hyphae, i.e. dimitic. All the others are monomitic but there are differences in the arrangement of the hyphae in different species. He further reported that some species have simple-septate hyphae, while they may be nodose-septate in others. Hyphal septation was used to distinguish between species of two out of the total of eight sections into which he divided this genus.

Maas Geesteranus (1962, 1964) found hyphal characters and anatomical structure to be of fundamental importance for the delimitation of genera in the Hydnaceae, and described differences in the morphology and arrangement of hyphae of a number of species whose carpophores consist of generative hyphae only. He stated: "The necessity and importance of the anatomical structure for the correct understanding of a genus becomes at once apparent when one considers *Steccherinum* as it was conceived by Banker and extended by subsequent authors . . . . . Also the apparent difficulty experienced by some authors sharply to delimit *Hydnellum* and *Sarcodon* disappears as soon as the hyphal system in both genera is taken into account." On the basis of this study of the generic types he concluded: "It is more than likely that, with the spines as the sole character in common, the connection of many of the hydnaceous genera, will have to be sought not within the 'Hydnaceae' but, irrespective of hymenial configuration, with groups now widely separted."

Bondartzeva (1963) discussed the use of the anatomical criteria for the taxonomy of the Aphyllophorales. She accepted Corner's (1932 a, b) concepts but concluded that the type of hyphal system is mainly of generic value in the taxonomy of this group. In cases, however, where adaptation to conditions of an external medium could have produced changes in the hyphal system, while other features make it evident that the species belong to the same genus, the type of the hyphal system may be either of supra-generic or infra-generic importance. She further regarded the type of hyphal system as an element of adaptive evolution. This view is supported by: (i) the relationship between the consistency of the context of the sporocarps and consequently their anatomical structure and the way of life of the species, and (ii) the limited number of types of hyphal systems and the occurrence of identical systems in species which differ widely in respect of other characters but are similar in ecological relationships. The anatomical structure, in her opinion, is an important indication of the life forms but not of the basic line ot evolution. The anatomical structure is thus an element of partial and not general evolution and hyphal systems of the fruit-bodies cannot be considered as one of the basic features in the development of a phylogenetic system. In this respect, Bondartzeva believes that the problem of convergence, which occurs widely in the Hymenomycetes, requires elucidation since it offers the key to the understanding of the complex phylogeny of this group of fungi.

Smith (1966) in his discussion of the hyphal structure of the basidiocarp stated that the mitic system (Corner's hyphal systems, 1932 a, b) is not very suitable for application to the Agaricales and thought it "ineffectual to set up special terms for generalized situations when they can be properly evaluated only by careful attention to detail." He thought the the terms such as "generative hyphae" fail to express adequately what is actually seen under the microscope in individual species. He considered descriptions of hyphal modifications, cell shape and microstructures, especially cystidia, to be important in taxonomic studies and agreed with Bondartzeva (1963) by stating that most hyphal modifications in the basidiocarps appear to be adjustments to meet the problem of moisture loss. The diversity in form and content of end cells of hyphae is due to the different ways which different species have evolved to meet this problem.

Donk (1964) used the concept of hyphal systems together with macro- and micromorphological characters to characterize the families of the Aphyllophorales. He regarded these hyphal systems and micromorphological characters as of great importance in taxonomy. His descriptions of families were preceded by concise reviews of the anatomical features.

The morphology of microscopic structures and hyphal modification was reviewed by Talbot (1954 a) and Lentz (1954). Both authors discussed in detail the morphology of the structures found in the fruit-bodies and hymenia of the Hymenomycetes, their origin and probable functions. Many examples were cited and misconceptions in the terminology corrected.

The application of hyphal characters and characters of microstructures by different workers to the taxonomic problems of the Hymenomycetes, has thus met with varying degrees of success. The concept of hyphal systems has been rejected by some and enthusiastically adopted by others, but all the workers mentioned here show in some way that hyphal morphology and modifications cannot be ignored in Hymenomycete taxonomy.

Pure Culture Studies

Hyphal morphology and modifications have also been shown to be of basic importance in the recognition of Hymenomycetes in pure cultures. Numerous workers who studied decay of timber have demonstrated that pure culture studies are important diagnostic tools in such work. Certain workers (e.g. Boidin, 1964) also regard pure culture studies to be of great value in taxonomic studies of Hymenomycetes.

Among the pioneers in this field were Long & Harsch (1918) who studied a large number of species in culture and introduced the terms still used to describe the texture of the mat. Fritz (1923) described 18 species, destructive to balsam fir, in detail and indicated the characteristics which should be used in the identification of decay fungi in pure culture. She indicated the importance of microscopic characters. Baxter (1924-1945) made extensive use of cultural characters in his taxonomic studies of resupinate polypores but described micro-morphological characters of the cultures only on rare occasions. Baxter used 2 per cent malt agar at temperatures of 25°C, 30°C and 35°C. Humphrey & Siggers (1933) studied the temperature relations of decay fungi and found that they could be grouped into three groups on the basis of their growth rates at different temperatures.

Bavendamm (1928) observed that fungi which cause white rot, were capable of darkening the colour of media containg gallic acid or tannic acid or other related compounds by oxidation. Species which cause brown rot did not cause darkening of the medium. This observation was later confirmed by Davidson, Campbell & Blaisdell (1938) who referred to this phenomenon as the "oxidase reaction". In a study involving 210 species of decay fungi, these authors found that these fungi could be divided into eight groups on the basis of their reactions when grown on malt agar media containing gallic acid or tannic acid. Of the fungi tested, 166 produced diffusion zones and 36 did not produce diffusion zones on either medium while seven fungi gave inconsistent results. Of the 36 fungi that were negative for extra-cellular oxidase, 30 were associated with brown rots while 151 species out of the 166 that were positive, were associated with white rots. These reactions proved to be useful diagnostic characters in the identification of cultures of decay fungi and were later incorporated by Davidson, Campbell & Vaughn (1942) in their descriptions of cultures of fungi causing decay of living oak in the Eastern United States. In this work, extensive use was made of microscopic characters of the hyphae and other specialized structures in the mat as well as macroscopic appearance of the cultures. These workers also introduced a key in which various characters of the different cultures were expressed by alphabetical symbols. This allowed the incorporation of new species into the key with a minimum of disruption.

Refshauge & Proctor (1936), studied Australian wood-decaying fungi in culture. They found that most of the fungi associated with white rot of timber were also capable of decolourizing certain dyes which had been added to the media. This was also found to be due to oxidation.

Jorgensen & Vejlby (1953) described a method for the preparation of an extract from red cabbage leaves to determine the presence of polyphenol oxidase enzymes in cultures of wood-rotting fungi. Etheridge (1957) suggested the use of meal of white spruce as an indicator medium for the presence of oxidase enzymes in white-rot fungi. More extensive studies of the occurrence and function of oxidase enzymes in wood-rotting fungi were carried out by Lyr (1955, 1963) and Luthardt & Lyr (1965).

The oxidation of phenolic compounds by wood-rotting fungi was reviewed by Käärik (1965) in her extensive study of the oxidation of 20 different phenolic compounds by a large number of decay fungi in pure culture. By applying drops of alcoholic solutions of the phenolic compounds to growing cultures of the fungi she found that four main types of reactions occurred, viz.: (i) production of tyrosinase only; (ii) production of laccase only; (iii) production of both laccase and tyrosinase, and (iv) production of neither laccase nor tyrosinase. On the basis of their reactions the mycelia could be divided into four groups which in turn could be sub-divided according to the intensity of the reactions and specific reactions to specific compounds.

Campbell (1938), in a study of 32 species of *Fomes* in culture, included extensive microscopic details of hyphae and structures formed in culture. The presence or absence of brown diffusion zones around mycelia grown on media containing gallic acid and tannic acid, was used as a diagnostic character in this work also.

Cartwright (1929, 1931), studied decay fungi in pure culture in England. In collaboration with Findlay he later described the cultural characters of many fungi causing decay of soft wood and hard wood trees and timber (Cartwright & Findlay, 1946). Their descriptions, which were devised primarily for the recognition of fungi from decayed timber, include details of microscopic structures, hyphae, physiological data and details of the decay.

A number of workers described wood-rotting fungi in culture from specialized habitats or a single host. Snell (1922) described fungi causing decay of building timber and in cotton mills. Walek-Czernecka (1933) described cultures of fungi from decayed railway sleepers in Poland. Davidson, Lombard & Hirt (1947) described fungi causing decay in wooden boats, while large-brown-spored house-rot fungi in the United States were described by Davidson & Lombard (1953). Earlier, Davidson & Campbell (1943) reported on nine species of decay fungi from black cherry. Robak (1942) described six species of decay fungi from pine in Norway.

A lack of similarity of methods adopted was apparent among these workers. This made it very difficult if not impossible to compare results reported by different authors. An attempt to overcome these difficulties was made by Nobles (1948) with the publication of descriptions of the cultural characters of 126 species of wood-rotting fungi from Canada. For this purpose the topography and colour changes of the mat as well as other macroscopic characters, the reactions on gallic acid and tannic acid media and micromorphological details of hyphae and other structures were combined in the descriptions of the various species. These characters were also reflected in a key for the identification of species, in which a number of characters, both macroscopic and microscopic, were represented by different numerals arranged in 11 vertical columns. This key, like that devised

by Davidson *et al.* (1942), is capable of continued expansion by the incorporation of new species. Later Nobles (1958 a) devised a rapid test for the presence of extra-cellular oxidase enzymes in cultures of decay fungi. By the application of a drop of an alcoholic solution of gum guaiac directly to a culture, the presence of extra-cellular oxidase enzymes is indicated by rapid blueing of the gum guaiac solution. No colour change occurs when the solution is applied to cultures of species that cause brown rots. Parallel tests on 33 species with the gum guaiac solution and the standard Bavendamm (1928) method, in which cultures are grown on malt agar containing gallic acid and tannic acid, gave identical results for nearly 90 per cent of the species. Inconsistent reactions were obtained by both methods from 19 species.

Nobles' methods were adopted by Van der Westhuizen (1958, 1959) for descriptions of South African wood-rotting fungi in culture. Very similar methods were used by Da Costa, Matters & Tamblyn (1952) for their descriptions of Australian wood-rotting basidiomycetes in culture.

Studies of pure cultures have been used by various workers to distinguish between species with morphologically similar carpophores. In many cases inter-collection pairing of mycelia each derived from a single basidiospore, a technique pioneered by Bensaude (1918), Vandendries (1922, 1923) and Kniep (1928), has been employed to enhance and confirm the results obtained from pure culture studies. The formation of hyphae with clamp connections when clampless mycelia each derived from a single basidiospore, are grown together in pairs, is regarded as positive proof of conspecificity of the mycelia and consequently of the spores and carpophores from which they were obtained. By using this method Mounce & Macrae (1936) showed that *Lenzites sepiaria*, *Lenzites trabea* and *Trametes americana*, which have very similar carpophores, are indeed three distinct species, while *Lenzites thermophila* is conspecific with *Lenzites trabea* because mycelia from single basidiospores from carpophores assigned to these two species, were interfertile. Later Mounce & Macrae (1937) found that no clamp connections formed when monosporous mycelia of *Fomes roseus* and *Fomes subroseus* were paired thus confirming the validity of the two species, which differ further in respect of spore shape and other minor characters of the carpophores. Nobles (1943) showed by this method that different cultures isolated from decay in pines were identical to those derived from a carpophore of *Poria microspora* and distinct from those of *Trametes serialis* which had been considered to be the cause of the decay. More recently, studies of cultural characters, including in most cases tests for interfertility, were used by various workers to solve taxonomic problems in Hymenomycetes. Among these were Bose (1952) and McKay (1959) with studies of *Polyporus cinnabarinus* and *Polyporus sanguineus*; McKeen (1952) with studies of three species of *Peniophora*; Nobles, Macrae & Tomlin (1957), various species of polypores; Harmsen, Bakshi & Choudhury (1958) with two species of *Merulius*; Sarkar (1959) with six species of *Coriolellus*; Davidson, Lentz & McKay (1960) with *Stereum* spp. causing pecky cypress; Denyer (1960) with two species of *Flammula;* Harmsen (1960) with *Merulius* spp.; Weresub & Gibson (1960) with *Stereum pini;* Aoshima, Lentz & McKay (1961) with *Stereum taxodii;* Boidin & Des Pomeys (1961) with various resupinate homobasidiomycetes; Lombard, Davidson & Lowe (1961) with *Fomes ulmarius* and *Poria ambigua;* Nobles & Frew (1962) with *Pycnoporus*; McKay (1962) with *Polyporus palustris* and other brown rot species; Lombard & Gilbertson (1965, 1966) with various *Poria* spp.; Macrae & Aoshima (1966) and Macrae (1967) with *Hirschioporus* spp.; Sen & Sehgal (1967) with twelve Indian polypores and McKay (1967) with *Polyporus meliae* and two similar species.

In some of these studies use was made of the "Buller phenomenon" to determine the identity of many of the cultures studied. Buller (1931) showed that a large monokaryotic mycelium of *Coprinus lagopus* was dikaryotized rapidly by a small inoculum of dikaryotic mycelium of the same species placed at its periphery. Kawamura (1941) showed that a haploid mycelium of *Polystictus sanguineus* could be dikaryotized by mating with a theoretically incompatible dikaryotic mycelium, produced by mating two haploid mycelia, neither of which was compatible with the test haploid mycelium. Terra (1953) summarized the literature on the "Buller phenomenon" and reported similar dikaryotization of a large haploid mycelium by small dikaryotic mycelia with *Schizophyllum commune, Leucoporus brumalis, Cytidia flocculenta,* and *Panus stipticus.* In these cases the haploid and dikaryotic mycelia were obtained from carpophores of the same species but collected in different regions. Boidin & Des Pomeys (1961) used this method in a study of certain species of resupinate Homobasidiomycetes. Nobles & Frew (1962) though that the "Buller phenomenon" could be a valuable tool for the confirmation of identification of cultures if it could be repeated with most species of the Hymenomycetes. In their study of the genus *Pycnoporus* Karst. these authors examined 103 cultures from many parts of the world. The identity of 57 isolates was confirmed by means of mating tests between single spore cultures while 46 isolates were identified by means of the "Buller phenomenon". Three types of reactions were observed, viz.: (i) a positive reaction in which the haploid test colony, originally composed of hyphae with simple septa, was converted to the dikaryotic condition, as shown by the presence of hyphae with clamp connections around the periphery; (ii) a negative reaction in which the haploid test fungus continued to grow in the haploid condition whilst the dikaryotic inoculum grew to produce a sector distinguishable by difference in colour or texture or growth rate, and (iii) a negative reaction in which the dikaryotic inoculum failed to grow; the test fungus grew around it, without dikaryotization taking place. By means of these tests, the isolates of *Pycnoporus* Karst. were divided into three groups of interfertile isolates. These three groups also exhibited similarities in cultural characters and carpophore morphology and anatomy within each group. The authors were thus able to distinguish between the three species of orange-red polypores which had originally been described under the specific epithets of *Polyporus cinnabarinus* Jacq. ex Fr., *Polyporus coccineus* Fr. and *Polyporus sanguineus* L. ex Fr. Van der Westhuizen (1963) used the "Buller phenomenon" to confirm the conspecificity of eight collections of *Cerrena unicolor* (Bull. ex Fr.) Murr., a white rot fungus which has the bipolar type of interfertility. Studies with pure cultures are thus valuable tools in taxonomic studies of the Hymenomycetes.

After extensive studies with pure cultures, Nobles (1958 b) presented a guide to the taxonomy and phylogeny of the Polyporaceae on the basis of their micromorphological characters and oxidase reactions in culture. In a study of 212 species, evidence was provided that the family is composed of two main groups: a primitive group consisting of species that produce no extra-cellular oxidase and, if heterothallic, show the bipolar type of infertility; and a more advanced group made up of species that produce extracellular oxidase and if heterothallic, show the tetrapolar type of infertility in those species whose hyphae are regularly nodose-septate and a third, intermediate and minor group of species in which the advancing hyphae are simple-septate but the older hyphae become nodose-septate, and which also display the bipolar type of infertility. Within each group, species were arranged in smaller groups on the basis of their hyphal characters in culture and basidiospore characters. In this way a total of 36 groups of species resulted. Some of these groups appear to represent natural taxa while others appear to require further sub-divisions suggesting supra-generic grouping, but whether homogenous or not, the groups can be arranged in the order of increasing complexity

of their hyphal structures to form a sequence suggesting their phylogenetic development. Nobles warned however that these groups can be accepted as representing natural taxa only if the cultural characters used in the segregation and arrangement of the species have recognizable counterparts in the carpohores of these species. The evaluation of the taxonomic significance of the groups thus requires correlated studies of the micromorphological characters of carpophores and cultures of the species in each group Later Nobles (1965) again presented these views in a diagnostic key with brief descriptions of 149 species of wood inhabiting Hymenomycetes devised primarily for their recognition in culture.

Some important facts are evident from Nobles' work, viz.: (1) there is little correlation between cultural characters and morphology, on the one hand and morphology and hymenial configuration of the carpophores, the traditional bases for generic delimitation, on the other; (2) hyphal characters such as septation and modification, in combination with spore characters, are regarded as of supra-generic or generic importance; (3) despite statements to the contrary by Whitehouse (1949) and Raper (1953, 1954) strong evidence is presented in favour of the view that the type of infertility is constant for each genus of the Polyporaceae; (4) the absence or presence of extra-cellular oxidase in culture is of prime phylogenetic importance; and (5) divisions between groups are based on a complex of characters. In a critical review of the most recent systems of classification of the Polyporaceae, Bondartzeva (1961) commented favourably on Nobles' views which she regarded as a sound approach to the development of a phylogenetic system of classification. Lowe (1963 a) did not agree with Nobles' views. He believed that the Hymenomycetes with short-lived fructifications composed of thin-walled, nodose-septate hyphae, are the more advanced species. He saw a parallel in the flowering plants, where fast-growing herbaceous annuals with resistant seeds are regarded as more advanced than woody perennials.

Studies in which structures found in culture were correlated with those of the carpophores as suggested by Nobles (1958 b), have since been undertaken by various workers. Sarkar (1959) studied six species of the genus *Coriolellus* Murr. which were all found to be similar in cultural characters and carpophore morphology. These six species which cause brown rots, do not produce extra-cellular oxidase enzymes in culture. Five of them were shown to have the bipolar type of infertility while one, *Coriolellus malicola,* was found to be homothallic. Sarkar showed tha ttaxonomically important characters found in cultures were also present in the corresponding carpophores from which the cultures were made.

Nobles & Frew (1962) in an exhaustive study of the orange-red polypore genus, *Pycnoporus* Karst., presented cultural, morphological and genetical evidence in support of the recognition of three species in this genus. All three species cause white rots of both hardwood and coniferous trees. The authors showed that hyphae, similar to those found in culture, are also present in the carpophores. Basidia and basidiospores too, were alike in both the cultures and carpophores but iodia which were present in most cultures were not found in the carpophores.

Van der Westhuizen (1963) showed that the thick-walled as well as thin-walled hyphae of *Cerrena unicolor* (Bull. ex Fr.) Murr. have clamp connections at the septa in both the cultures and fruit-bodies. This fungus differed in this respect from the type species of the different genera to which it had been referred.

Farinha (1964) described the characters of the hyphae from carpophores and cultures of 30 species of polypores according to the methods of Pinto-Lopes (1952). She concluded that the microscopal characters of the secondary hyphae of the carpophores and those from cultures of the same species are identical. This

also applied to some kinds of tertiary hyphae, but other forms of growth were apparently lacking in culture. She thought that a large number of species should be studied in detail before a general terminology for the different types of hyphae could be devised. Such a terminology should take the different forms of growth of the hyphae, throughout the life cycle, into consideration and should be applicable to hyphae from the carpophores as well as from cultures on artificial media.

Lombard & Gilbertson (1965) described the cultural characters and carpophores of 14 species of *Poria* with negative or weak oxidase reactions. These species displayed different hyphal characters but in most species the hyphae present in the cultures were also present in the carpophores. Only in those species in which nodose-septate hyphae with irregularly thickened walls were present in the cultures, were those hyphae not found in the carpophores as well.

It thus appears that most of the structures formed in cultures, may also be found in the carpophores. A statement to this effect had been made by Pinto-Lopes (1952) but was not supported by any evidence at that time. It must however be determined whether this is true for all species of Hymenomycetes and whether some of the hyphal modifications described in cultures, such as cuticular cells and hyphae with interlocking projections, are also present in the carpophores of the relevant species and, finally, whether the relationships indicated by cultural characters can also be demonstrated to exist between the fruit-bodies.

3. MATERIALS AND MEHODS

Materials

Culture media:

1.25 per cent Difco malt agar;

1.25 per cent Difco malt agar + 0.5 per cent tannic acid;

1.25 per cent Difco malt agar + 0.5 per cent gallic acid.

Extra-cellular oxidase enzyme test solution:

0.5 gm gum guaiac in 30 cc of 96 per cent alcohol, (Nobles, 1958 a).

Mounting media for microscope preparations:

5 per cent aqueous KOH solution (Talbot, 1951);

1 per cent aqueous phloxine solution (Talbot, 1951);

Lactophenol (Smith, 1960).

Specimens for study:

Dried fruit-bodies from the following herbaria were examined: National Herbarium, Mycological Collection, Pretoria (PRE); P. A. van der Bijl Herbarium, University of Stellenbosch (STE); Canada Department of Agriculture, Mycological Herbarium, Ottawa, Ont. (DAOM); New York Botanical Gardens, New York, (NY); Royal Botanic Gardens, Kew, England, (K); Farlow Herbarium of Cryptogamic Botany, Cambridge, Mass., U.S.A. (FH).

Abbreviations of these herbaria are according to Lanjouw & Stafleu (1964).

Fresh, living fruit-bodies were collected at random in different localities, as indicated in the descriptions of different species, in Canada and South Africa.

Cultures were available for study from the collections in the Mycology Section, Department of Agricultural Technical Services, Pretoria and the Mycology Section, Plant Research Institute, Canada Department of Agriculture, Ottawa.

Methods

Cultural characters were studied by growing the different fungi on 1.25 per cent Difco malt agar plates. Agar was poured to a depth of about 4 mm into 90 mm petri dishes for this purpose and the plates were inoculated at the side. Four to six plates were made of each isolate. The cultures were incubated at room temperature, 72° — 76°F, in the dark for six weeks. Cultures were examined macroscopically and microscopically at weekly intervals and details of texture, colour and topography were recorded. Details of micromorphological characters of structures from different parts of the mycelial mat, mounted in a mixture of equal parts of KOH solution and phloxine solution (Talbot, 1951) or lactophenol and examined with the aid of the high dry and oil immersion lenses, were recorded and illustrated by means of camera lucida drawings and photomigrographs according to methods described by Nobles (1948) and Van der Westhuizen (1958).

The production of extra-cellular oxidase enzymes by the growing mycelia were detected either by the application of a drop of alcoholic gum guiacum solution to the growing mycelium, (Nobles, 1958 a) or by growing the fungi on plates of malt agar containing 0.5 per cent gallic acid and 0.5 per cent tannic acid for seven days (Davidson, Campbell & Blaisdell, 1938). The appearance within a few minutes of a blue colour in the gum guaiacum solution and dark coloured zones in the malt-gallic acid and malt-tannic acid media, presented positive proof of the production of extra-cellular oxidase enzymes by the fungus under test.

Cultures of single basidiospores were obtained by suspending freshly collected fruit-bodies in damp chambers. Under these conditions basidiospores were shed on sterile glass slides placed under them. The spores were then suspended in sterile water. Small quantities of this suspension, (about 1 ml) were poured over malt agar plates which were incubated for about 24 hours. Afterwards, single germinating spores were picked off under a dissecting microscope by means of a sterile inoculating needle and transferred to malt agar slants. The absence of clamp connections on the mycelia which developed from these spores, was regarded as an indication that they originated from single spores.

The type of interfertility of individual species was determined by mating pairs of inocula from single basidiospore cultures on malt agar slants. For this purpose 16 cultures, each grown from a single basidiospore obtained from one carpophore, were used. Inocula from these single spore cultures were placed in pairs, about 15 mm apart on malt agar slants and incubated until the mycelia developing from them met and mingled on the slant. Inocula from each set of 16 single basidiospore cultures were mated in this way in all possible combinations. After incubation the resultant mycelia on these slants were examined microscopically for the presence of clamp connections which would indicate compatible mating types in the parent single basidiospore mycelia. The results were plotted in a pairing table, as illustrated by Macrae (1967) among others, but are presented here in the abbreviated form used by Yen (1950), Nobles, Macrae & Tomlin (1957) and Nobles & Frew (1962).

Pairings between different isolates of species for which single basidiospore cultures were available, were made by mating three or four single spore mycelia from each collection in all possible combinations in the way described above. The formation of clamp connections on the resultant mycelia was regarded as positive proof of the conspecificity of the collections from which the single spore cultures were obtained.

When single spore cultures were not available for all collections examined for each species, attempts were made to determine conspecificity of the collections by

dikaryotizing a large monokaryotic mycelium with a small dikaryotic mycelium placed at the periphery of the growing monokaryotic colony, according to the "Buller phenomenon" as described by Buller (1931), Terra (1953), Boidin & Des Pomeys (1961) and Nobles & Frew (1962). The appearance of clamp connections on the peripheral hyphae of the monokaryotic mycelium within four to seven days after contact between the growing mycelia, was regarded as positive proof of genetic compatibility of the two mycelia and hence conspecificity of the two collections involved.

To study the anatomy and hyphal morphology of the carpophores, thick radial-longitudinal sections were cut from them and examined as described by Teixeira (1956). Small portions about 5 x 2 x 1 mm were removed from different parts of these sections at the margin, the upper surface, upper and lower context, tubes and stipes when present, and soaked in a mixture of equal parts of KOH and phloxine. With the aid of sharpened sewing needles, these portions were then gently teased out and dissected by transmitted light under 25 x magnification of a dissecting microscope to obtain undamaged hyphae and other micro-structures for examination. Excess material was removed from the slide and the dissected parts were covered with a coverslip and examined in the KOH-phloxine mixture with the aid of the oil immersion lens. Both fresh and dried fruit-bodies were examined in this way.

Radial-longitudinal sections of fruit-bodies were also cut with the aid of a freezing microtome at a thickness of 15μ and mounted in lactophenol or the KOH-phloxine mixture in order to study the relationships and orientation of hyphae in the carpophores.

The hyphal characters of both cultures and carpophores were described in accordance with Nobles' (1948, 1958 b, 1965) terminology, but terms proposed by Corner (1932 a), Teixeira (1962 b) and Donk (1964) were also used.

All colours in quotation marks are according to Ridgway (1912).

The description of each species given below, was compiled from examination of all the specimens cited for that species. Collections of which the cultures were also examined, are indicated by an asterisk (*) placed before the herbarium number. All the sets of drawings were similarly compiled from drawings of structures from the different collections.

4. KEY TO GROUPS OF SPECIES STUDIED

In the following descriptions of species studied, the species are placed in groups based mainly on their cultural characters, as proposed and numbered by Nobles (1958 b). A key to these groups is given below:

1.	Extra-cellular oxidase reaction in culture negative	2
1.	Extra-cellular oxidase reaction in culture positive	5
2.	Only thin-walled, nodose-septate hyphae formed in culture	3
2.	Thin-walled, nodose-septate hyphae and fibre hyphae formed in culture	4
2.	Thin-walled, nodose-septate hyphae, fibre hyphae and nodose-septate hyphae with irregularly thickened walls formed in cultures ...... Group	25
3.	Basidiospores subglobose to ovoid ...... Group	7
3.	Basidiospores allantoid ...... Group	9
4.	Mycelial mat in culture white ...... Group	18
4.	Mycelial mat in culture brownish ...... Group	13

5. Mycelial mat consisting of thin-walled, nodose-septate hyphae only Group 32
5. Mycelial mat consisting of thin-walled, nodose-septate hyphae and fibre hyphae .... Group 45
5. Other special structures present in the mat besides thin-walled, nodose-septate hyphae and fibre hyphae 6
6. Cuticular cells also present .... Group 51
6. Hyphae with irregular or interlocking projections present as well ...... Group 53

5. DESCRIPTIONS OF SPECIES

5.1 Group 7

Cultures of species in this group form white mycelial mats which do not produce extra-cellular oxidase enzymes; their thin-walled hyphae have simple clamps at the septa, do not form thick-walled, aseptate fibre hyphae and rarely form chlamydospores. Their basidiospores are globose, ovoid or ellipsoidal. Their interfertility is of the bipolar type with multiple allelomorphs for heterothallism at one locus only.

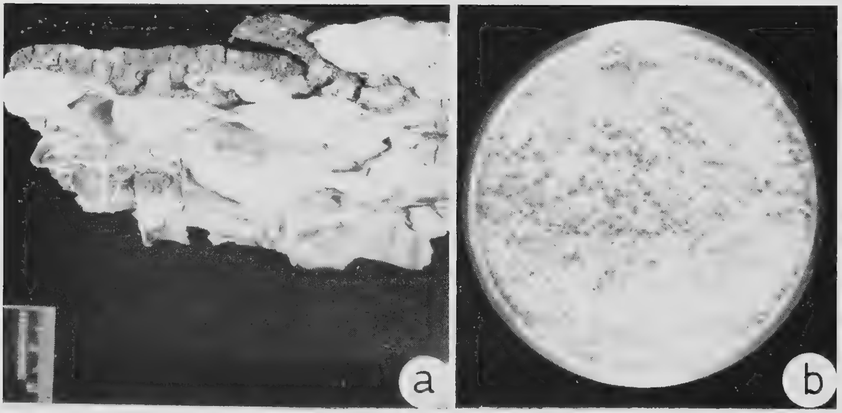

Fig. 1.—**Polyporus adustus.** (a) Carpophores of DOAM 53500; (b) culture of PRE 42039 at six weeks.

Polyporus adustus *Willd. ex. Fr.*, Syst. Myc. 1, 363, 1821;

Boletus adustus Willd., Fl. Berol., p. 392, 1787;

Bjerkandera adusta (Willd. ex Fr.) Karst., Medd. Soc. Fauna Fl. Fenn. 5, 38, 1879;

Leptoporus adustus (Willd. ex Fr.) Quél., Ench. Fung., p. 177, 1886;

Gloeoporus adustus (Willd. ex Fr.) Pil., Atl. Champ. Eur., III, (I), 157, 1936.

Cultural characters

Growth is fairly rapid, the plates being covered in two to three weeks. The advancing zone is even, with hyphae raised and extending to the limit of growth. Mat at first white, loose, thick, cottony to woolly over large areas but soon forming a zone of pale "cream-buff" colour about half-way across the plate where the mycelium appears more compact and tends to agglutinate in strands forming a vague network over the surface of the agar. Mat remains white, raised, but after four weeks collapsing in the pockets of the network and becoming more appressed felty, assuming a dirty white colour. The network of agglutinated hyphae increases slowly in extent and darkens in colour to "pale ochraceous buff," while irregular, rounded, lumps of compact, felty mycelium ranging in colour from "tilleul buff" to "avellaneous" or "Dresden brown" may form along the sides of the dish, becoming poroid later. At six weeks the mat may be appressed, thin, felty, pellicular for some distance around the inoculum, raised in the darker areas, but collapsed elsewhere with small patches of thin, white, felty, mycelium similar to that around the inoculum, appearing on the agar surface. Odour faint to fairly strong, unpleasant mushroomy. Reverse is bleached. Oxidase reaction with gum guaiac is variable being either negative or weakly positive to strongly positive in one case. On gallic acid and tannic acid media, no growth or a trace of growth may take place but no diffusion zones are produced. Reactions observed from different isolates are tabulated in TABLE I.

Advancing mycelium: hyphae hyaline, thin-walled, branching at or near the septa, nodose-septate with deeply staining contents and often with short, repeatedly branched lateral branches submerged in the agar, 2.5 — 4.0μ in diameter, (Fig. 2a).

Aerial mycelium: (a) hyphae hyaline, thin-walled, nodose-septate, branching at the septa as in the advancing zone, 2.0 — 4.5 μ (Fig. 2 a); (b) nodose-septate hyphae as in (a) but with walls somewhat thickened and tending to be refractive or occasionally solid, 3.0 — 5.2μ in diameter. In coloured areas similar hyphae are numerous but with the contents dark-coloured, often with simple septa present as well or, in parts, without contents (Fig. 2b); (c) narrow, hyaline hyphae, repeatedly branched and tapering to slender tips 0.4 — 0.6μ in diameter arise from thin- or thick-walled nodose-septate hyphae and become tightly interwoven to form the tough, pellicular patches on the agar in some isolates (Fig. 2c); (d) oidia hyaline, elongate, ovoid, cylindrical or irregular, thin-walled 3.0 — 9.0μ x 2.0 — 3.0μ very numerous in some isolates (Fig. 2d); (e) chlamydospores intercalary and terminal, ellipsoid, ovoid, thick-walled, with staining contents 7.0 — 13.0 x 4.5 — 9.0μ wide, found in two isolates (Fig. 2e).

Fructifications: composed of nodose-septate hyphae with slightly thickened walls as in (b), tightly interwoven and with dark coloured contents, 2.5 — 3.5μ in diameter; basidia arising on these hyphae, small hyaline, ovoid to narrowly clavate, with 4 slender, straight sterigmata, 11.0 — 15.0 x 4.0 — 5.5μ, sterigmata 2.0 — 2.5μ; spores hyaline, smooth ovoid or ellipsoid, thin-walled, with a small apiculus 3.0 — 3.6 x 2.4 — 3μ (Fig. 2f).

Submerged mycelium: hyphae hyaline, nodose-septate, walls slightly thickened, often with a number of small lateral branches arising close together (Fig. 2g).

Carpophore characters.

Carpophore annual, lignicolous, grouped or occasionally compound, sessile, effused-reflexed to almost entirely resupinate, occasionally dimidiate; pileus applanate, flabellate or spathulate often imbricate and laterally connate, soft, somewhat spongy when fresh drying to hard, rigid, 1.5 x 3 — 10 x 0.1 — 0.8 cm; surface

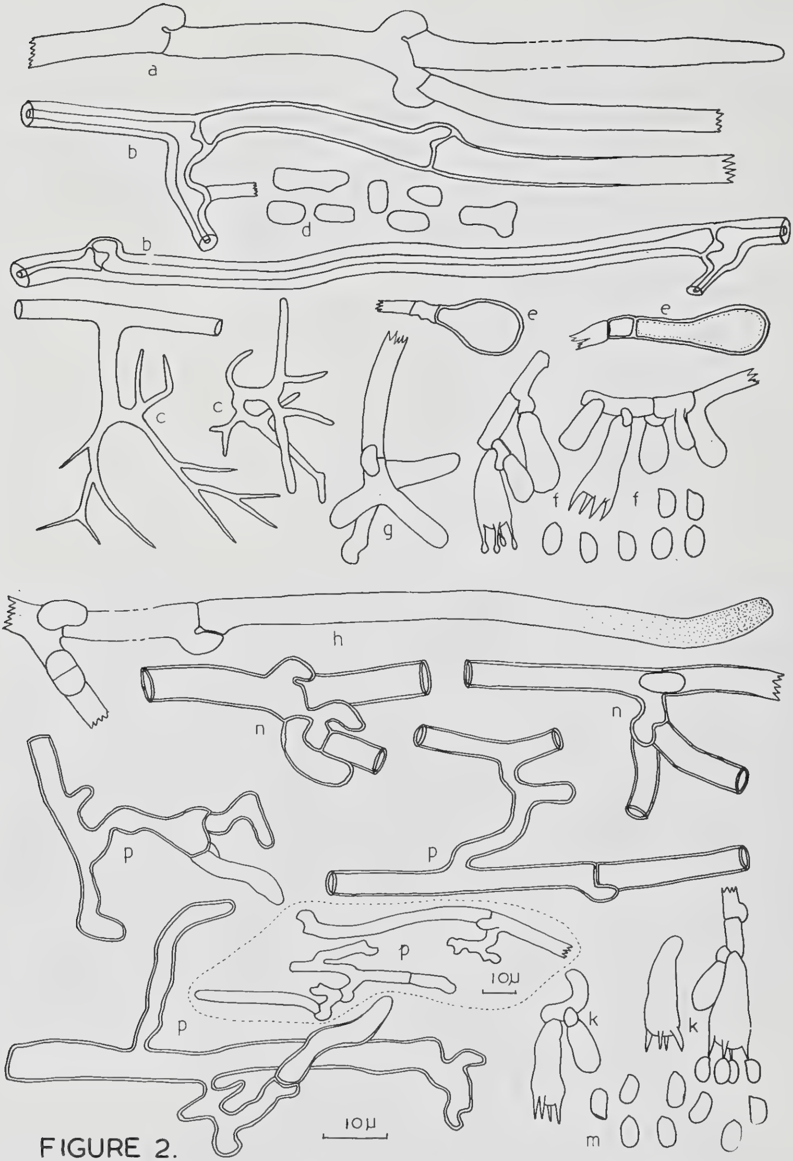

Fig. 2.— **Polyporus adustus.** a - f. Hyphae and structures from cultures: (a) thin-walled, nodose-septate hyphae from advancing zone; (b) thick-walled, nodose-septate hyphae; (c) narrow, branching hyphae; (d) oidia; (e) chlamydospores; (f) basidia and spores; (g) submerged hypha with lateral branches.

h - p. Hyphae and structures from carpophores: (h) thin-walled, nodose-septate hypha with dark-coloured contents; (k) basidia; (m) basidiospores; (n) thick-walled, nodose-septate hyphae from context; (p) nodose-septate context hyphae with lateral, branched, binding processes.

velutinate to somewhat villose, occasionally glabrescent, smooth or concentrically sulcate, pale creamy white when fresh often with a faint blueish tint, drying to smoky grey, cinereous or pale tan; margin acute, thin, entire, occasionally lobate, concolorous or slightly darker and drying to black, sterile below for 1 — 2 mm; pore surface grey to greyish black or darker where bruised, drying to dark brownish grey; pores angular, minute 4 — 7 per mm; dissepiments even or somewhat irpicoid, tubes concolorous, in one layer, up to 2 mm deep; context white or nearly so, often ochraceous 1 — 6 mm thick, azonate or occasionally with a dark zone and with a brown or blackish line above the tubes and extending into the dissepiments.

Hyphal characters: hyphae nodose-septate, more or less straight or flexuous to tortuous, branching at or near the septa, the branches more or less straight or flexuous to very tortuous, walls hyaline or faintly coloured, thin, or variously thickened with contents hyaline or dark brown, 1.8 — 5.0μ diameter (Fig. 2h).

Hymenium: basidia short, broad clavate to narrow ovoid 11.0 — 15.0 x 4.0 — 5.5μ with 4 slender, straight sterigmata 2.0 — 2.5μ long and borne in clusters on the short, thin-walled, terminal and sub-terminal cells of the tortuous hyphae of the dissepiments (Fig. 2k); basidiospores ellipsoidal to ovoid, hyaline, smooth, thin-walled, with a small apiculus, 3.0 — 3.6 x 2.4 — 3.0μ (Fig. 2m).

Construction. At the margin, the pileus consists of branching, thin-walled, nodose-septate hyphae intertwined and extending to the extreme edge. Contents of some hyphae are dark-brown imparting the dark edge to some pilei (Fig. 2h). The upper context consists of hyaline, nodose-septate hyphae with walls only slightly thicker than in the margin or with walls much thickened, clamp connections conspicuous, branching at or near the septa 2.8 — 4.75μ in diameter (Fig. 2n). These adhere together in strands running parallel to or inclined upward from the direction of growth of the pileus. Individual hyphae bend away from these strands to join others so that an open lattice-like structure is formed. Hyphae from the context project upward to a common level forming the upper surface, where they are agglutinated by a faintly brownish, laquer-like substance into small tufts or, the ends free, hyaline, with dark contents or empty, thin-walled, 2.0 — 4.7μ in diameter. The lower context consists of nodose-septate hyphae, as in upper context, with slightly thicker, occasionally almost solid, hyaline walls and dark brown contents, turning downward toward the trama and dissepiments, intertwined and tortuous and narrowing to 1.8 — 3.0μ and walls somewhat thinner. From these, lateral branches arise with numerous septa and conspicuous clamp connections, very tortuous, profusely branched, narrow 1.5 — 3.0μ, tightly binding other hyphae and branches into a smooth, dense tissue (Fig. 2p). The edges of the dissepiments consist of slightly interwoven parallel, hyaline, nodose-septate hyphae 1.8 — 3.0μ in diameter.

Decay and hosts

Polyporus adustus causes a white rot of various species of hard woods (Cartwright & Findlay, 1946; Nobles, 1948).

Specimens examined

* Indicates culture studied as well.

Herb. DAOM: 9209, on *Fagus grandifolia,* Chelsea, Que., Oct. 1937; 10157, on *Thuja occidentalis,* Oakville, Ont., Jan. 1941; *17571, on *Populus tremuloides,* Brule, Alta., Oct. 1947; *17575, on *Ostrya virginiana* stump, Chelsea, Que., Oct. 1947; 17889, on *Populus*

tremuloides, Candle Lake, Sask., Oct. 1959; *22576, on *Populus* sp., Sheep Island, Lake Opinicon, Ont., Sept. 1950; *53500, on hardwood, Pack Forest, Warrensburg, N.Y. Oct. 1959. *Herb.* PRE: 15607, on *Podocarpus elongatus*, Harold Forest, Natal, Sept. 1915; 24859, Kirstenbosch, C.P., June 1929; 30383, on *Fagus sp.*, U.S.D.A., Washington, F. P. 52045; 31420, Stellenbosch, C.P., July 1919; 31462, Stellenbosch, C.P., May 1921; 35949, Oxshott, England, Oct. 1946; *42039, on *Populus* sp. log, Stellenbosch. Aug. 1959; *42328, on hardwood log, Dorset, Ont., Sept. 1962 (DAOM 94016); *42329, on hardwood log, Dorset, Ont., Sept. 1962 (DAOM 94010); *42332, on hardwood log, Dorset, Ont., Sept. 1962 (DAOM 73987); *42350, on dead deciduous tree, Dorset, Ont., Sept. 1962 (DAOM 94014); *42365 on *Acer* sp. log, Packenham, Ont., Aug. 1962 (DAOM 94007).

Interfertility studies

When tested for the production of extra-cellular oxidase in culture, the isolate from South Africa showed a strong positive reaction while some of the cultures of Canadian origin showed no reaction. Nobles (1958 a) reported a similar variable reaction for *Polyporous fumosus* which Overholts (1953) described as closely similar to and at times indistinguishable from *Polyporus adustus*. Nobles (1958 b) further reported *Polyporus fumosus* as having the tetrapolar type of interfertility while *Polyporus adustus* has the bipolar type of interfertility. It was therefore necessary to determine whether the South African isolate was interfertile with other isolates and therefore conspecific with Canadian collections of *Polyporus adustus*. For this purpose four cultures obtained from single spores from the South African isolate PRE 42039, were paired with similar cultures isolated from Canadian collections of *Polyporus adustus*. These single spore cultures were paired in all possible combinations on malt agar slopes. The results are presented in Table 2 according to the method of Nobles, Macrae & Tomlin (1957), Macrae (1967) and others.

From the results, it is clear that all the Canadian isolates of *Polyporus adustus* used, were interfertile. The South African isolate only had a low degree of interfertility with the Canadian isolates of *Polyporus adustus*. In three out of a total of 48 pairings numerous clamps were formed. This South African collection differed from the Canadian collection only in respect of the more intense reaction of its culture when tested for extra-cellular oxidase, but was closely similar in all other respects. It can thus be concluded that this South African isolate is conspecific with the Canadian isolates of *Polyporus adustus* but belongs to a different geographical race. The existence of geographical races had been reported by Mounce & Macrae (1938) for *Fomes pinicola*, a species with bipolar interfertility.

Discussion

All hyphae formed in cultures of *P. adustus* are nodose-septate with hyaline walls. Hyphae from various parts of the culture differ only in the thickness of the wall, overall diameter and manner of branching while differentiated hyphae are lacking. Differences in cultural characters between different isolates exist only in the absence or presence of accessory spores and the intensity of the reaction for extra-cellular oxidase when tested with gum guaiac solution.

The narrow, repeatedly branched hyphae in the pellicular patches of the mat of some of the isolates have not been reported before. Chlamydospores were reported from cultures by Cartwright (1931) and oidia by Nobles (1948). Chlamydospores were present in some of the cultures only but oidia were present in all cultures although their numbers varied considerably in the different isolates.

This description of the cultural characters agrees fairly closely with that of Nobles (1948) and earlier descriptions by Bose (1930), Cartwright (1931), Cartwright & Findlay (1946) and Davidson, Campbell & Blaisdell (1938).

Irregularities in the reaction of this fungus when tested for extra-cellular oxidase in culture, have been reported by Davidson *et al.* (1938) and Nobles (1958 a) who found that the reaction may vary from negative to weakly-positive on gallic acid and tannic acid media. Davidson *et al.* (1938) stated that "these fungi may require from 7 to 14 days to form brown diffusion zones but the reactions are always positive." Nobles (1958 a) recorded a strong positive reaction with her gum guaiac test. The results given in Table 1, however, show that no positive reactions were obtained on gallic and tannic acid media even after 14 days and that results with the gum guaiac test also varied from negative to positive. Yet all workers reported that *Polyporus adustus* causes a white rot. Lyr (1955) reported that *Polyporus adustus* were among the 13 species out of 103 wood-rotting fungi tested by him which formed peroxidase in small amounts. Most of those species which formed peroxidase were also able to utilize lignin by oxidation and cause white rots. He thought that the peroxidase could act like laccase, the extra-cellular oxidase enzyme present in most white-rot, lignin-destroying Hymenomycetes, in this respect. It thus seems probable that the weak and erratic reactions observed when *Polyporus adustus* was tested for extra-cellular oxidase may be due to small and varying amounts of peroxidase enzyme formed by different isolates of this species. Differences in the intensity of the reaction when different isolates of 173 species of wood-rotting Hymenomycetes were tested for oxidase enzymes by the application of drops of various compounds, were reported by Käärik (1965).

The above description of the fruit-body of *Polyporus adustus* agrees with that of Overholts (1953) who described the hyphae in the carpophore as "hyaline, considerably branched with cross-walls and clamps, 3 — 6μ in diameter." Teston (1953 b) and Cunningham (1948 b) reported that the carpophores are monomitic and consist of thin-walled, generative hyphae with numerous clamp connections. Pinto-Lopes (1952) and Farinha (1964) stated that the secondary hyphae are hyaline and nodose-septate, while the tertiary hyphae are nodose-septate and with walls never much thickened. Donk (1933), reported that fruit-bodies of this fungus consist of thin-walled, nodose-septate hyphae, more or less parallel in arrangement and forming a loose tissue in the upper part of the trama but closely packed and parallel in the lower part from where hyphae turn downward into the trama of the tubes. Bourdot & Galzin (1928) similarly reported thin-walled nodose-septate hyphae loosely interwoven in the upper context and very compact and closely packed and parallel in arrangement in the lower context. Ames (1913) also reported a difference in the consistency between the upper and lower layers of the context of this fungus but did not describe the morphology of the hyphae. All these descriptions thus agree that the fruit-bodies consist of nodose-septate hyhpae only and have a monomitic hyphal system while most reports by earlier workers agree that the hyphae are arranged more or less in parallel. These descriptions thus imply that the hyphae are all similar in appearance and that the fruit-bodies are simple in construction. From the description furnished above, and illustrations of hyphae, (Fig. 2h, n, p) it is evident that marked morphological differences exist between hyphae from the upper and lower context. Hyphae from the upper context are straight and sparingly branched with the septa far apart while hyphae from the lower context are tortuous, frequently branched and have septa fairly close together, and often lie across the direction of growth. Hyphae similar to those of the upper context are also present in the trama. By their tortuous branching in the lower context, all hyphae are tightly bound into the dense, tough tissue so characteristic of the lower context and trama of *Polyporus adustus*. Differences in the morphology of these hyphae are thus related to differences in the consistency and texture between the upper and lower parts of the carpophore on the one hand and function of the hyphae on the other hand.

Many of the lateral branches of hyphae binding the tissues in the lower context, resemble the binding hyphae described by Corner (1953) in the tissues of *Polyporus sulphureus,* in that they are lateral processes which differ from the parent hyphae solely in the method and extent of branching and in function. They do not resemble the binding hyphae described by Cunningham (1946) which are differentiated, branching, thick-walled, aseptate structures. It is thus clear that there is a diversification of function among the thin-walled, nodose-septate hyphae that make up the fruit-body of *Polyporus adustus.* The fruit-bodies are thus more complex in construction than was evident from previous descriptions. This complex construction may prove to be valuable in taxonomic considerations of this and other monomitic species.

A comparison of the structures formed in culture with those found in the carpophore, shows that in both, all hyphae are nodose-septate, although differences in the thickness of the walls are evident. The thick-walled hyphae found in the carpophore are however of the same type as those of the culture. The narrow, branching hyphae found in the felty, pellicular patches of the mat in culture appear to be homologous to the much branched, tortuous hyphae found in the lower context and trama of the carpophore. Basidia and basidiospores formed in culture are similar in all respects to those of the carpophores. With the exception of chlamydospores and oidia, structures formed in cultures of *Polyporus adustus* are thus present in the carpophores as well.

Polyporus adustus is the type species of the genus *Bjerkandera* Karst. (Cooke, 1959; Donk, 1960), but has also been referred to other genera by various workers. It differs from *Polyporus squamosus* Huds. ex Fr. and *Polyporus tuberaster* Jacq. ex Fr. the lectotypes of the genus *Polyporus* Mich. ex Fr. according to Murrill (1907 a) and Donk (1960), respectively. Carpophores of *Polyporus adustus* do not possess the characteristic thick-walled hyphae with tapering ends which are present in the fruit-bodies of these two species (Corner, 1953; Overholts 1953). Cultures of *Polyporus adustus* lack the dark, skin-like areas consisting of thick-walled hyphae with interlocking projections which characterize cultures of *Polyporus squamosus* and *Polyporus tuberaster* (Nobles 1948, 1958 b). Quélet (1886) placed *Polyporus adustus* in his genus *Leptoporus* and was followed in this by Bourdot & Galzin (1928) but there is uncertainty about the type species of this genus. *Polyporus mollis* Pers. ex Fr. the lectotype selected by Donk (1960), differs from *Polyporus adustus* by having the carpophore composed of "thick-walled, hyaline, sparingly branched hyphae with a few inconspicuous cross walls but no clamp connections" (Overholts, 1953). The identity of *Polyporus epileucus* Fr., the type species selected by Murrill (1903), is confused with that of *Polyporus spumeus* Fr. (Bourdot & Galzin, 1928). Murrill (1903), regarded the genus *Leptoporus* (Quél.), as synonymous with *Bjerkandera* Karst. and was followed in this by Donk (1933), Bondartzev & Singer (1941), and Bondartzev (1953), but a study of descriptions of hyphae by Overholts (1953), Teston (1953 b), and Pinto-Lopes (1952), of species placed in the genus *Leptoporus* by Bourdot & Galzin (1928), revealed many differences in hyphal characters between these species. It thus seems advisable to retain *Polyporus adustus* in the genus *Bjerkandera* Karst. of which it is the type species. The problems concerning its relationship with species of the genus *Leptoporus* Quél. can be solved only after the uncertainty about the type species of that genus had been clarified and its hyphal characters had been carefully studied.

Polyporus adustus cannot be regarded as congeneric with *Polyporus conchoides* Mont., the type of the genus *Gloeoporus* Mont. because it lacks the hymenium which is continuous over the edges of the pores, a characteristic of the genus *Gloeoporus* (Overholts, 1953; Hansen, 1956; Donk, 1960)

5.2 Group 9

The mycelial mats of cultures of species in this group remain white and do not produce extra-cellular oxidase enzymes; their thin-walled hyphae have simple clamps at the septa, do not form thick-walled, aseptate fibre hyphae and rarely form chlamydospores. Their basidiospores are cylindrical or allantoid. Their interfertility is of the bipolar type.

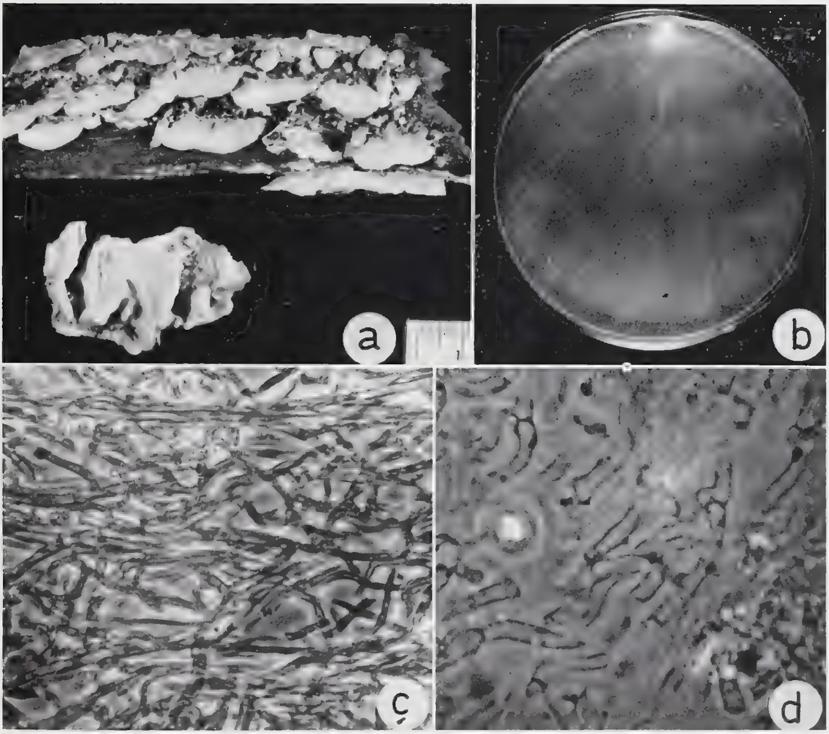

Fig. 3.— **Polyporus dichrous.** (a) Carpophores of PRE 42093 (top) and PRE 42384 (bottom); (b) culture of PRE 42384 at 6 weeks; (c) radial-longitudinal section through carpophore showing nodose-septate hyphae and hyphal strands of context, × 500 phase contrast; (d) delicate, thin-walled, nodose-septate hyphae of tramal layer, × 1000 phase contrast.

Polyporus dichrous *Fr.*, Syst. Myc 1, 364, 1821;

Leptoporus dichrous (Fr.) Quél., Fl. Myc., p388, 188;

Gloeoporus dichrous (Fr.) Bres., Ann. Mycol. 14, 230, 1916.

Cultural characters

The mycelium grows fast to moderately fast covering the plate in two to three weeks. Advancing zone even or slightly bayed, appressed or submerged and difficult to see. Mat hyaline to whitish, mostly submerged, with small, scattered areas of

finely farinaceous to short floccose mycelium developing after four weeks. Reverse remaining unchanged or developing a characteristic greenish-yellow colour after two to four weeks. Odour strong, unpleasant after two or three weeks then diminishing somewhat.

No diffusion zones formed on gallic acid and tannic acid media but trace of growth on the latter after seven days. Oxidase reaction with gum guaiac solution, negative.

Advancing mycelium: hyphae hyaline, branching, nodose-septate, thin-walled, 2.0 — 4.5μ in diameter (Fig. 4a).

Aerial and submerged mycelium: (a) hyphae as in the advancing zone; (b) narrow, hyaline, unbranched, thin-walled hyphae with conspicuous clamp connections and 1.5μ in diameter (Fig. 4b); (c) nodose-septate hyphae occasionally with irregular swellings up to 7.0μ in diameter, between the septa (Fig. 4c).

Carpophore characters

Carpophore annual, lignicolous, sessile, effused-reflexed or often imbricate; pileus 1.5 — 7.0 x 3.0 — 10.0 x 0.1 — 0.5 cm mostly pure white to faintly yellowish and coriaceous when fresh, drying creamy to ochraceous, rigid and brittle; surface velvety-villose to glabrous, azonate, mat when dry; margin entire, acute, concolorous, white, sterile below; pore surface waxy, flesh-coloured to reddish-purple, poroid; pores rounded, or somewhat angular, entire, thin-walled, 5-8/mm; tubes shallow less than 1 mm and hymenial surface separable from pileus as a thin elastic layer; context white, soft fibrous, thin, 1-4 mm.

Hyphal characters: hyphae branching, hyaline, nodose-septate, thin-walled or thick-walled 1.5—8.0μ in diameter (Fig. 4d, e).

Hymenium: basidia cylindrical to narrowly clavate 12.0 — 15.0 x 2.0 — 4.0μ with four short, straight sterigmata 1.5 — 2.0μ, the basidia packed into a tight palisade continuous over the dissepiments (Fig. 4f); basidiospores allantoid, hyaline, smooth, thin-walled 3.0 — 4.0 x 0.7 — 1.0μ (Fig. 4 g).

Construction. At the margin of the fruit-body the hyphae are narrow, 2.2 — 5.0μ in diameter, thin-walled and slightly interwoven parallel to the direction of growth of the pileus. Behind the margin in the upper context the hyphae become thick-walled (sclerified generative hyphae; Donk, 1964), and the branches more divergent and up to 8.0μ in diameter. Here the hyphae tend to form intertwined strands from which individual branches diverge to join adjacent strands thus forming a loose, lattice-like structure (Fig. 3c). Towards the upper surface the strands disappear and the hyphae are divergent, loosely interwoven, their ends thin-walled, free or agglutinated into irregular tufts which form the upper surface. Below this tissue, the loosely arranged, thick-walled hyphae pass rather abruptly into a dense layer, 40 — 80μ thick, of branching, thin-walled, tortuous, nodose-septate hyphae tightly interwoven into a pseudo-parenchymatous tissue. From this layer narrow hyphae 1.5 — 3.0μ in diameter with very thin, delicate walls turn downwards, branch occasionally and run parallel to or lightly intertwined with one another towards the hymenium where they branch profusely to form a narrow, sub-hymenial layer on which the basidia are borne. On the hyphal walls masses of amorphous granules of gelatinous material are deposited so forming the characteristic gelatinous tramal layer 50 — 300μ thick in fruit-bodies of this species (Fig. 3 d).

The small cylindrical basidia are borne on the pseudo-parenchymatous sub-hymenial layer 5.0 — 15.0μ thick formed by the numerous terminal branches of the thin-walled hyphae of the tramal layer. The hymenium is continuous over the edges of the pores.

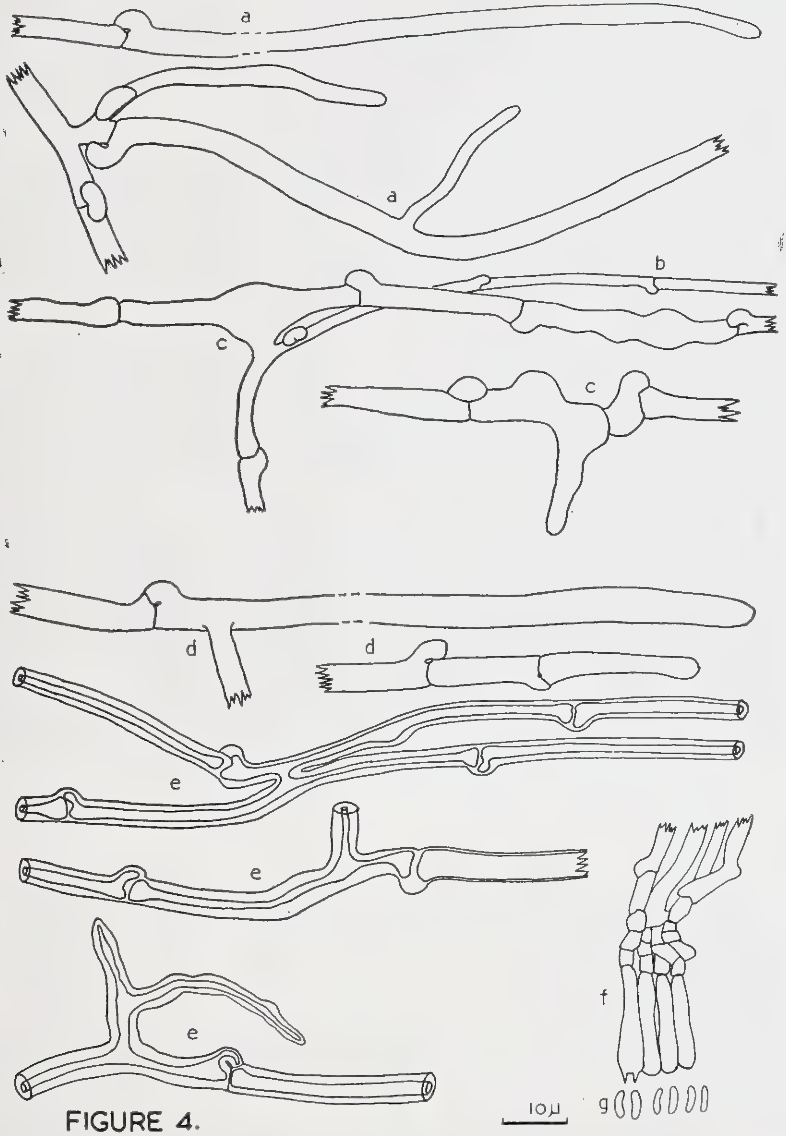

FIG. 4. — **Polyporus dichrous.** a - c. Hyphae from cultures: (a) hypha from advancing zone; (b) narrow, hyaline, unbranched, thin-walled hypha with conspicuous clamp connections; (c) hypha with irregular swellings.
d - g. Hyphae and structures from carpophores: (d) thin-walled, nodose-septate hyphae; (e) thick-walled nodose-septate hyphae; (f) basidia; (g) basidiospores.

Decay and hosts

Polyporus dichrous causes a white rot of angiosperm wood.

Specimens examined

Herb. DAOM: *8118, on *P. contorta* var. *latifolia,* Lumby B.C.; *11609; *22281.
Herb. PRE: 15617, Gingindhlovu, Natal, June 1915; 22285, Mycotheca Boreali Africana No. 349, R. Maire; 23479, Mont-aux-Sources, Natal, July 1928; 27739, on dead wood, Donnybrook, Natal, Jan. 1935; 28924, dead wood, Donnybrook, Natal, Febr. 1935; 30511, on dead wood, Potchefstroom, Transvaal, March 1939; 31602, on dry wood of *Rhus viminalis,* Aug. 1915; 31814, on dead wood, Nottingham Road, Natal Aug. 1917; 40205, Town Bush, Pietermaritzburg, June 1948; 41486, Ex Herb. Wm. Bridge Cooke No. 30137; 42093, on dead log, Potgietersrust Dist., March 1960; *42384, on decaying log, Gatineau Park, Que., Sept. 1961; *42436, on decaying log, Barberton, Tvl., May 1960.

Interfertility studies.

Eighteen cultures, each grown from a single basidiospore obtained from a fresh carpophore of PRE 42384, were paired in all possible combinations on malt agar tubes to determine the type of interfertility. It was found that *Polyporus dichrous* has the tetrapolar type of interfertility with allelomorphs for heterothallism at two loci. The results, showing the distribution of mating types among the single spore mycelia, are presented in TABLE 3.

To test the conspecificity of collections of which cultures were available, by means of the "Buller Phenomenon," two mycelia from single spores of opposite mating types of PRE 42384-8 and PRE 42384-10 were used. The method described by Nobles & Frew (1962) in their studies of species of the genus *Pycnoporus* Karst., was used. Seven days after placing the dikaryotic mycelium on plates on which the haploid mycelia were growing, the latter were examined for the presence of clamp connections at the periphery. Results were negative. After five days more, the plates were again examined. No clamp connections had formed on any of the haploid mycelia, which had been inoculated with small dikaryotic mycelia from all the cultures studied of *Polyporus dichrous.*

It thus appears that the "Buller phenomenon" cannot be effectively used for confirming the identity of cultures of *Polyporus dichrous.*

Discussion

This description of the cultural characters of *Polyporus dichrous* agrees closely with those of Davidson *et al.* (1938) and Nobles (1948, 1965). The featureless mycelial mat, the greenish-yellow colour imparted to the agar, the usual lack of extra-cellular oxidase and the thin-walled, nodose-septate hyphae serve to distinguish this species in culture.

Cultures of *Polyporus dichrous* do not give positive reactions when tested for extra-cellular oxidase on gallic and tannic acid media but may give a weak positive reaction with gum guaiac solution (Nobles, 1965). Davidson *et al* (1938), and Nobles (1948) reported that this species causes a white rot. Overholts (1953) stated that the decay associated with it is "usually white, but careful dissection often shows a small amount of definitely brown rot in the vicinity of the sporophores". He thought that the fungus probably causes a brown, carbonizing rot, because of the negative reaction for extra-cellular oxidase. Petersen (1961), reported that this fungus causes a brown rot of deciduous fruit trees in the U.S.A. Käärik (1965) found no reaction when two isolates of *Polyporus dichrous* were tested for oxidative ability of 20 different phenolic compounds. Kirk & Kelman

(1965), found that although cultures of *Polyporus dichrous* gave negative reactions on 9 different phenolic compounds, the fungus caused a white rot of sweet gum test blocks. Extracts made of these blocks contained a phenol-oxidase active against catechol and guaiacol but not 1-napthol. Extracts of cultures of this fungus contained a weak catechol oxidizing agent inactive against guaiacol or 1-napthol. These authors concluded that "inability of certain wood decay fungi to oxidize phenols in agar cannot be assumed to indicate inability to utilize lignin". These observations could explain the erratic results of tests for extra-cellular oxidase by *Polyporus dichrous* and may indicate the presence of oxidation enzymes different from those of many other species of polypores which cause white rot.

The hyphae formed in the cultures were always thin-walled and nodose-septate and resembled those in the margin and gelatinous tramal layer of the fruit-body. Thick-walled, nodose-septate hyphae like those in the context of the fruit-bodies, were seen once in an old culture. These thick-walled, nodose-septate hyphae of the carpophores, are "sclerified generative hyphae" (Donk, 1964) and are formed by internal thickening of the walls of thin-walled, nodose-septate hyphae. The hyphae formed in cultures of *Polyporus dichrous* are thus present in the fruit-bodies as well.

The gelatinous nature of the trama of the pores of *Polyporus dichrous* had been mentioned by many earlier workers (Van der Bijl, 1922 a; Bourdot & Galzin, 1928; Overholts, 1953). The construction of this layer was first described by Hansen (1956) as consisting of hyphae with strongly gelatinized walls. From the present writer's observations it is clear that the gelatinous tramal layer consists of narrow, branched, nodose-septate hyphae with very thin walls which are placed more or less vertically in a loose palisade-like tissue of which the interstitial spaces are filled by a hyaline, amorphous substance (Fig. 3 d). In freshly mounted, radial-longitudinal sections of the fruit-body in KOH-phloxine, this substance could be seen as an unstained mass extruded from the section, in the otherwise bright pink colour of the mounting medium. In thin sections mounted in sterile distilled water, this substance could also be seen as a slightly darker mass, oozing out of the tissues, when observed by means of a phase contrast microscope. The thin-walled, tramal hyphae are clearly visible in extremely thin sections of about 5μ or less in thickness. This construction would explain Van der Bijl's (1922 a) observation that the tubes are "separable from the context as a thin elastic layer when moistened."

The hyphae of the fruit-body are all nodose-septate so that this fungus has a monomitic hyphal system as reported by Cunningham (1948 b) and Hansen (1956), but from the above description of the fruit-body, which agrees in most respects with that of Hansen (1956) it is evident that the thick-walled, nodose-septate hyphae of the context support the layer of thin-walled, interwoven hyphae from which the thin-walled, tramal hyphae and hymenium are suspended. These differences in hyphal morphology which is associated with differences of function, result in a much more complex construction of the fruit-body of *Polyporus dichrous* than that of fruit-bodies of species of *Thelephoraceae* which also possess monomitic hyphal systems (Talbot, 1951, 1954 b, 1958 b). Similar differences in morphology and function of hyphae were also found in the carpophores of some other species of poroid Hymenomycetes with monomitic hyphal systems such as *Polyporus adustus* (see previous section) and *Cerrena unicolor* (Van der Westhuizen, 1963).

The gelatinous tramal layer and hymenium which is fertile over the edges of the pores are important morphological characters of the carpophores of *Polyporus dichrous*. These characters are not found in any of the other species in Group 9 (Nobles, 1958 b) and are absent from most species of poroid Hymenomycetes. These

characters are found in species of the genera *Merulius* Hall. ex Fr., and *Gloeoporus* Montagne. The fruit-body of *Merulius tremellosus* Schrad. ex Fr., the type of the genus *Merulius*, also has a gelatinous layer under the hymenium and appears to resemble the fruit-body of *Polyporus dichrous* in construction (Burt, 1917). Cultures of *Merulius tremellosus*, however, were placed by Nobles in her Group 54 (1958 b) together with other species characterized by the presence of simple-septate hyphae in the advancing zone and nodose-septate hyphae elsewhere, a positive reaction for extra-cellular oxidase and the bipolar type of inter-fertility. Another species, *Merulius ambiguus* Berk. which also has a gelatinous layer under the hymenium, (Burt, 1917), differs in cultural characters from *Merulius tremellosus* by forming mycelial mats consisting of thin-walled, simple-septate hyphae, occasionally with multiple clamp connections and a negative reaction when tested for extra-cellular oxidase. *Merulius ambiguus* was placed by Nobles (1958 b) in Group 28, together with other species with similar cultural characters. Some other species, viz., *Merulius lacrimans* Wulf. ex Fr., the type of the genus *Serpula* Pers. ex S. F. Gray, (Cooke, 1959) *Poria incrassata* Berk. & Curt., the type of *Meruliporia* Murrill (Cooke, 1959), and *Poria taxicola* (Pers.) Bres. (Hansen, 1956) all have hymenia which are continuous over the edges of the dissepiments but they lack the gelatinous tramal layer in their fruit-bodies. (Burt, 1917).

No descriptions of the cultural characters of *Gloeoporus conchoides* Mont., the type of the genus *Gloeoporus* Mont., are available but the carpophores of *Polyporus dichrous* and *Gloeoporus conchoides* are so similar in morphology and anatomy that the two species can often be distinguished from each other only by the absence of clamps on the hyphae of the latter species according to Overholts (1953) and Bakshi & Singh (1961). Although this may be regarded as a difference of generic importance between the two species, some genera of Hymenomycetes are known to include species with as well as without clamps on their septate hyphae. Because these two species have so many other characters in common, it seems advisable to include *Polyporus dichrous* in the genus *Gloeoporus* Montagne.

The possession of an hymenium which is fertile over the edges of the dissepiments, excludes *Polyporus dichrous* as well as other species of *Gloeoporus* Mont. from the Polyporaceae. Donk (1964) advanced arguments for the inclusion of this genus together with the genus *Merulius* Fr. and other genera with similar characters in the family Corticiaceae Herter. The observations recorded here support this proposal.

5.3 Group 13

The mycelial mats of cultures of species in this group mostly develop brown, coloured areas due to the presence of brown pigment in the hyphal walls or contents. No extra-cellular oxidase enzymes are produced. The thin-walled hyphae have simple clamp connections at the septa and brown, aseptate fibre hyphae are formed in most of their cultures. Their basidiospores are brown and ovoid or ellipsoid-cylindric in shape. Interfertility is of the bipolar type.

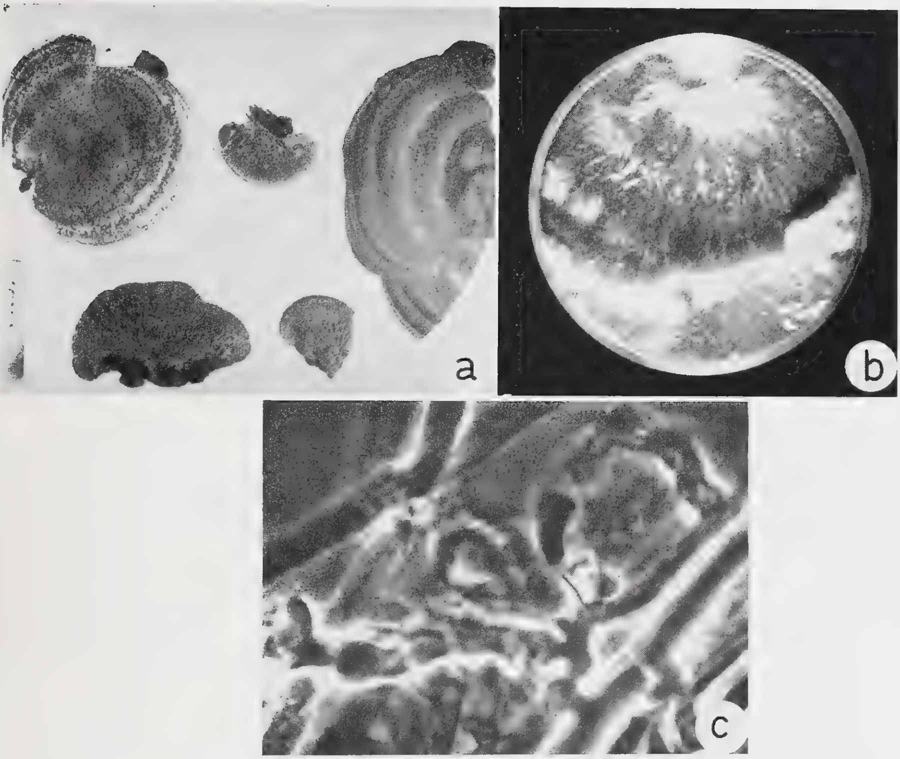

FIG. 5. — **Lenzites saepiaria.** (a) Carpophores of DOAM 22745; (b) culture of DAOM 22443 at six weeks; (c) nodose-septate hypha with lateral outgrowth with spiny projections in culture, × 1000 phase contrast.

Lenzites saepiaria *(Wulf. ex Fr.) Fr.* in Epicr. Syst. Myc. p. 407, 1838;

Daedalea saepiaria Wulf. ex Fr., Syst. Myc. 1, p. 33?, 1821;

Gloeophyllum saepiarium (Wulf. ex Fr.) Karst., Finl. Hattso. II, p. 80, 1879.

Cultural characters

Growth moderately fast to slow, the mycelium covering the plate in three to seven weeks. The advancing zone is even; mat thin, appressed, becoming somewhat downy-farinaceous, or downy in younger parts with thin, sub-felty or irregular pellicular areas in the older parts of the mat, some of which may become slightly warted; mat white at first but turning "pale buff" changing to "warm buff" or "antimony yellow" or "honey yellow" to "tawny olive" or "snuff brown" to "umber brown" in patches. Occasionally mounds or ridges of raised, floccose, woolly mycelium appear, white at first, then darkening to "antique brown" or "snuff brown" and often with irregular patches of thin, collapsed mycelium between these mounds. Reverse unchanged or bleaching slowly; odour none or faint,

somewhat spicy. No diffusion zones on tannic acid and gallic acid agar and slight growth only on the latter.

Advancing mycelium: hyphae hyaline, thin-walled, nodose septate, branching at the septa or from the clamp connections, 2.2 — 5.2μ in diameter (Fig. 6 a).
Aerial mycelium: (a) hyphae as in the advancing zone 2.0 — 3.5μ in diameter; (b) narrow, hyaline, nodose-septate hyphae, repeatedly branched, thin-walled at first, becoming thick-walled to solid, 1.0 — 2.5μ diameter, and with swollen projections or lateral outgrowths with numerous short, spiny projections or lateral outgrowths (Fig. 5c; 6b); (c) nodose-septate hyphae with thickened, brown walls and narrow lumina with staining contents, branching near the septa or from the clamp connections, 2.2 — 4.2μ in diameter (Fig. 6c); (d) fibre hyphae sub-hyaline to pale straw yellow, occasionally branched, walls thickened to sub-solid or solid, aseptate 2.2 — 3.6μ in diameter (Fig. 6d); (e) oidia long cylindrical, hyaline, thin-walled 6.0 — 13.0 x 3.0 — 4.2μ (Fig. 6e); (f) chlamydospores rare, ovoid to subglobose, terminal, 6.0 — 8.0 x 6.0 — 12.0μ (Fig. 6f). *Submerged mycelium:* (a) hyphae as in the advancing zone; (b) nodose-septate hyphae with walls thickened or solid, branched, numerous 1.2 — 3.6μ in diameter (Fig. 6b).

Carpophore characters

Carpophore lignicolous, solitary or grouped, annual or reviving; sessile, usually dimidiate occasionally effused-reflexed; pileus applanate to somewhat convex often laterally connate, occasionally imbricate, coriaceous when fresh, drying to rigid, 1.0 — 10.0 cm x 1.0 — 8 cm x 0.2 — 1.0 cm; upper surface hirsute-tomentose to fibrillose-tomentose or compactly tomentose at maturity, bright yellow-reddish brown to dark ferruginous; margin acute, thin or thick, entire, pale cream coloured to almost orange; pore surface yellowish brown to rusty brown, usually lamellate, occasionally daedaloid or poroid, lamellae often dentate, 0.5 — 1.0 mm apart and 2.0 — 5.0 mm broad; context up to 3 mm thick, umber to chestnut brown, darkening in KOH.

Hyphal characters: (1) nodose-septate hyphae hyaline or pale yellow, thin-walled, occasionally collapsed, branching frequently near the septa or from the clamp connections, 2.0 — 3.0μ in diameter (Fig. 6 g); (2) nodose-septate hyphae with thick, yellow-brown walls, and lumina narrow or solid, 2.5 — 4.0μ in diameter, with occasional thin-walled branches (Fig. 6 h); (3) fibre hyphae long, unbranched or occasionally branched, walls thickened, pale straw yellow to yellow brown with lumina narrow or occluded but widening towards the apex, aseptate or with one or two simple septa near the tip, 2.5 — 4.0μ in diameter (Fig. 6 k); (4) fibre hyphae pale brown, subsolid to solid, repeatedly branched, the branches short or long, flexuous, aseptate 1.5 — 3.0μ in diameter (Fig. 6 m).

Hymenium: basidia long-clavate, hyaline 20 — 32 x 4.0 — 5.0μ with four slender sterigmata 3.9 — 4.8μ (Fig. 6 n); basidiospores cylindrical, obliquely apiculate, hyaline, smooth, thin-walled, 7.0 — 10.0 x 2.0 — 4.0μ (Fig. 6 p); cystidioles fusiform resembling immature basidia but with slightly thicker walls 22.0 — 33.0 x 3.0 — 5.0μ, arising on basidial hyphae and protruding 5.0 — 7.0μ above the basidia (Fig. 6 q).

Construction. At the margin the pileus consists of long, unbranched fibre hyphae, aseptate, their walls partly thickened and sub-hyaline. The fibre hyphae lie parallel to the direction of growth of the pileus, are somewhate intertwined with their ends projecting outward to form the margin. Interwoven with the fibre hyphae and away from the extreme margin are numerous, hyaline, thin-walled, nodose-septate hyphae 2.2 — 3.5μ in diameter branching frequently at the septa or from the clamp connections. Behind the margin in the upper context, the fibre

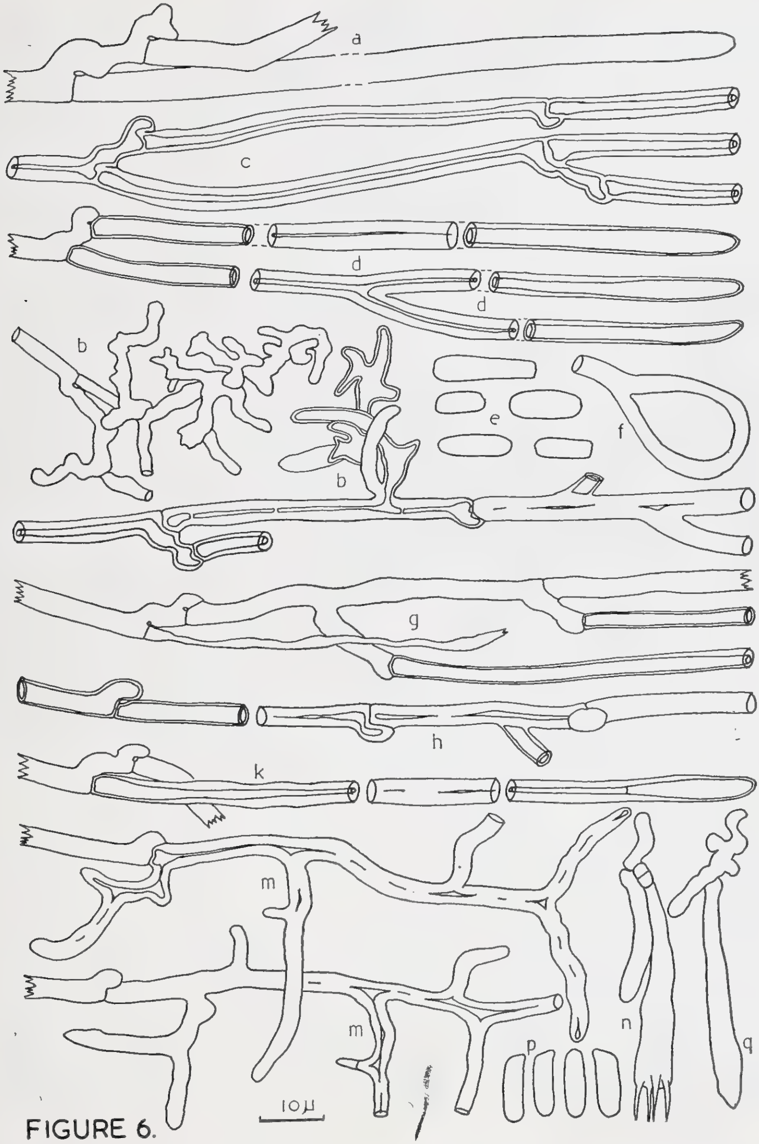

FIGURE 6.

Fig. 6. — **Lenzites sepiaria.** a - f. Hyphae and structures from cultures: (a) nodose septate from advancing zone; (b) nodose-septate hyphae with lateral outgrowths; (c) thick-walled, brown nodose-septate hyphae; (d) fibre hyphae; (e) oidia; (f) chlamydospores.

g - q. Hyphae and structures from carpophores: (g) nodose-septate hyphae; (h) thick-walled, nodose-septate hyphae; (k) fibre hyphae, unbranched; (m) fibre hyphae with short, flexuous branches; (n) basidium; (p) basidiospores; (q) cystidiole.

hyphae have thickened, pale, straw-yellow walls and narrow lumina. They are turned slightly upward towards the upper surface, are somewhat intertwined, 2.5 — 4.0μ in diameter with their tips free and projecting at a common level to form the pubescent, pale-coloured upper surface of the growing margin. Interwoven with these fibre hyphae are nodose-septate hyphae with thin, pale yellow walls, often collapsed, with deeply staining contents and branching freely or forming H-connections. In the dark-coloured part of the context the fibre hyphae are mostly sub-solid to solid, unbranched, 2.5 — 4.0μ in diameter, their walls dark yellow brown, the hyphae somewhat intertwined and turning upwards towards the upper surface of the pileus. At the upper surface these hyphal ends are agglutinated into tufts by a brownish, amorphous substance and bent over towards the margin to form the fibrillose-tomentose upper surface of the mature, dark-coloured part of the pileus. Below this fibrillose-tomentose layer, the fibre hyphae are agglutinated into a trichocutis by a thin layer of pale brownish substance. Below this layer and in the older parts of the context the nodose-septate hyphae are interwoven with the fibre hyphae, have thick, yellow-brown walls with the lumina narrow or occluded and the hyphae sub-solid or solid, 2.5 — 4.0μ in diameter (Fig. 6 h). Also present in the older parts of the context are fibre hyphae with pale brown, thickened walls, aseptate and branching repeatedly, the branches 1.5 — 5.3μ in diameter, short or long, tortuous, tightly interwoven with the other hyphae and binding them into a tough tissue (Fig. 6 m). Below the upper context the fibre hyphae turn downwards towards the trama of the pores. The fibre hyphae are similar to those of the upper context but remain somewhat narrower, 2.2 — 3.0μ in diameter and are more tightly intertwined and consequently more flexuous. Fibre hyphae with short, numerous branches with thickened walls are very numerous, binding all hyphae into a tough tissue. The nodose-septate hyphae in this part of the pileus mostly have thickened, pale brown walls and branch freely from the clamp connections or at the septa. In the trama and towards the hymenial surface these hyphae become more numerous, thin-walled, the walls sub-hyaline, and with deeply staining contents, branching freely and interwoven with the other tramal hyphae, finally protruding at the hymenial surfaces where they bear the basidia and cystidioles on short terminal branches.

Decay and hosts

Lenzites sepiaria causes a brown, carbonizing rot of dead coniferous wood or occasionally of hardwood.

Specimens examined

Herb. DAOM: *17240, on *Betula papyrifera,* Goose Bay, Lab., July, 1947; *17246, on *Pinus mariana,* Goose Bay, Lab., July, 1947; *22276, on *Populus tremuloides* log, Quesnel, B.C., Aug. 1949; *22442, on *Picea* stump, Algonquin Park, Ont., Sept. 1950; *22443, on *Tsuga* or *Pinus* log, Dorset, Ont., Oct. 1950; *22745, Goose Bay, Labrador, Aug., 1949; 22761, on *Picea mariana* log, Goose Bay, Lab., May 1950; 30059, on *Picea glauca* log, Riding Mt. Nat. Park, July 1950; 31986, base of *Picea* sp. North Bay, Ont., Sept. 1955.
Herb. PRE: 41887 on *Picea canadensis,* ex Herb. J. R. Weir, Aug. 1917; 42141 on *Pinus* sp. log, Mac-Mac Falls, Transvaal, July, 1961, *42381 on coniferous log, Corkery Road, Ont., Aug. 1962.

Discussion

This fungus appears to be quite variable in culture. Snell (1922) reported that the fungus is recognizable in culture by its scant aerial mycelium and powdery appearance due to abundant oidia. Robak (1942) and Cartwright & Findlay (1946) confirmed this and reported patches of thicker, orange-brown, velvety mycelium on which flat, antler-like, basidia-bearing processes develop. Nobles (1948) described the farinaceous appearance and numerous oidia of the cultures but did

not mention fibre hyphae. Falck (1909) described two kinds of hyphae from cultures, viz.: (1) conducting hyphae in which the cross walls disappear at the clamp-connections and (2) hyphae with very thick walls and narrow lumina which give mechanical strength. These latter correspond to the fibre hyphae described above. Fibre hyphae were not present in all cultures studied and chlamydospores were present in cultures of DAOM 22442 and PRE 42381 only. All cultures however had abundant oidia while the thick-walled, nodose-septate hyphae were present in varying numbers in all the cultures. These hyphae may be identical to Falck's (1909) conducting hyphae. The variability of the cultural characters of this fungus makes its identification in culture rather difficult on occasion.

In this species, most of the types of hyphae formed in culture are also found in the carpophores. The peculiar lateral outgrowths of short branches and the roughened processes produced on the fibre hyphae and thick-walled, nodose-septate hyphae in culture, were not found in any of the carpophores.

Bourdot & Galzin (1928) described the hyphae from carpophores of *Lenzites sepiaria* as brownish and thick-walled. Cunningham (1948 h), considered this species to fall in the genus *Daedalea* Pers. ex Fr., as defined by him and thereby implied the presence of thin-walled, generative hyphae with clamp connections at the septa, and thick-walled, brown, aseptate skeletal and binding hyphae in the carpophores. Pinto-Lopes (1952) reported hyaline, thin-walled, nodose-septate, secondary hyphae and brownish, narrow, aseptate, subsolid or solid tertiary hyphae in the carpophores. Overholts (1953) stated: "hyphae mostly pale chestnut, rarely branched, thick-walled, with no crosswalls or clamps, 3 —— 5μ in diameter, a few hyphae paler or nearly hyaline, with clamps." Teston (1953 b) confirmed the existence of nodose-septate generative hyphae, aseptate, thick-walled, skeletal hyphae and narrow, sinuose, branched, binding hyphae in the carpophores of this species. The description given above thus agrees with those of earlier workers. The binding hyphae of this species are thus true binding hyphae as defined by Corner (1932 a, 1953). The brown, thick-walled, nodose-septate hyphae ("sclerified generative hyphae," Donk, 1964) which are fairly numerous in the older part of the context have not been mentioned before. The carpophores thus have the types of hyphae and construction of species with a trimitic hyphal system as defined by Corner (1932 a), Cunningham (1946, 1954) and Teixeira (1962 b).

Lenzites sepiaria was chosen as the type species of the genus *Gloeophyllum* by Karsten, (Donk, 1960) but Fries (1821) placed it in *Daedalea* Pers. ex Fries before transferring it to *Lenzites* Fries a few years later (1838). Cunningham (1948 h) considered this species to be congeneric with *Daedalea quercina* L. ex Fr. the type of the genus *Daedalea* Pers. ex Fr. (Cooke, 1959; Donk, 1960). Although Cunningham (1948 h) defined the genus *Daedalea* as having a trimitic hyphal system, it was found in the course of this work that *Daedalea quercina* does not have "binding hyphae" in the carpophores (c.f descriptions Group 25). Furthermore, cultures of *Daedalea quercina* do not form brown colours; the hyphae are all hyaline and the cultures are characterized by the presence of nodose-septate hyphae with irregularly thickened walls which are absent from cultures of *Lenzites sepiaria*. Because of these differences, *Lenzites sepiaria* cannot be placed in the genus *Daedalea* Pers. ex Fries.

Although *Lenzites betulina* (L. ex Fr.) Fries, the type species of the genus *Lenzites* Fries, has the trimitic type of hyphal system, (Cunningham, 1948 h; O. Fidalgo, 1957) it differs from *Lenzites sepiaria* by having hyaline hyphae in both the cultures and carpophores. Its cultures produce extra-cellular oxidase and the fungus causes a white rot. It also has the tetrapolar type of interfertility (Nobles, Macrae & Tomlin, 1957) while *Lenzites sepiaria* has the bipolar type (Mounce &

Macrae, 1936). It thus appears that *Lenzites sepiaria* is not well classified with species of *Lenzites* either and is best placed in the genus *Gloeophyllum* Karst, of which it is the type species (Donk, 1960).

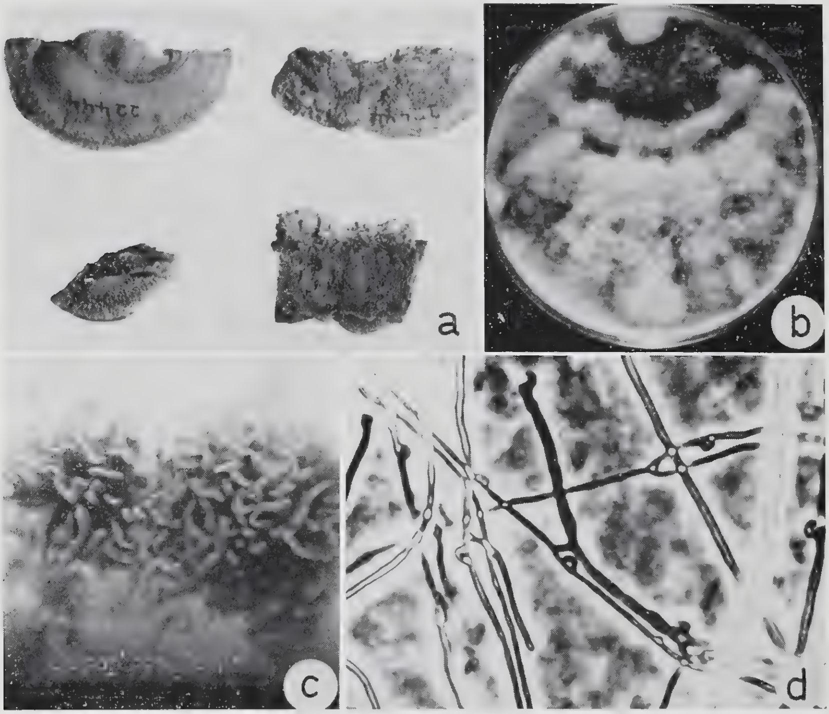

Fig. 7.—**Lenzites trabea.** (a) Carpophores of DAOM 22444; (b) culture of PRE 42457 at six weeks; (c) antler-like fructifications in culture; (d) wide and narrow nodose-septate hyphae from culture, × 1000 phase contrast.

Lenzites trabea *Pers. ex Fries,* Epicr. Syst. Myc. p. 407, 1838;

Daedalea trabea Pers. ex Fr., Syst. Myc. I, 335, 1821;

Trametes trabea (Pers. ex Fr.) Bresadola, Hym. Hung. Kmet. 27, 1897;

Gloeophyllum trabeum (Pers. ex Fr.) Murrill, Bull. Torr. Bot. Cl. 32, 370, 1905;

Coriolopsis trabea (Pers. ex Fr.) Bond. & Sing., Ann. Mycol. 39, 62, 1941;

Phaeocoriolellus trabeus (Pers. ex Fr.) Kotlaba and Pouzar, Ceská mykologie 9 (3) 152 — 170, 1957.

Cultural characters

Growth moderately fast, plates covered in 3-4 weeks, mycelial mat reaching a radius of about 30 mm after 1 week. Margin even, mycelium raised or in some cultures appressed, thin, downy, usually loose cottony to woolly at first, almost white to "light buff." Mat becomes progressively more woolly with age, darkening to "cream buff" or "light ochraceous buff" to "pale orange-yellow" with patches

of "orange buff" later turning to "apricot buff" or "ochraceous orange" and fans of mycelium growing over the lid of the Petri dish from the sides of the cultures. Fruiting bodies develop from the second week onward as dark "apricot buff" patches of compact, felty mycelium from which slender rounded spines, "apricot buff" in colour grow up, later expanding into flat, lamellate structures forming loose, irregularly poroid fructifications. At six weeks, mat mostly raised, woolly, radially and concentrically sulcate and "maize yellow" with darker fruiting or incipient fruiting areas, or, with large, irregular areas of thin, downy mycelium, or, sodden, appressed patches among areas of raised, woolly, "pale ochraceous buff" or "maize yellow" mycelium. Reverse bleaching slowly at first, then darkening in patches to "cadmium yellow," "deep chrome," "capucine orange" or "xanthine orange". Odour faint or strong, suggesting garlic. No diffusion zones are formed on gallic acid and tannic acid media; no growth on the latter medium but up to 20 mm diameter colonies on gallic acid media. No reaction occurs when gum guaiac solution is applied to the mat.

Advancing mycelium: hyphae hyaline, thin-walled, nodose-septate, branching from the clamp connections 3.0 — 4.5μ in diameter, (Fig. 8 a).

Aerial mycelium: (a) hyphae as in the advancing zone; (b) fibre hyphae rare, long, narrow, hyaline at first but turning yellowish gradually, unbranched or occasionally branched, the branches long, walls thickened, refractive, lumina narrow or occluded, aseptate, 2.0 — 3.0μ in diameter, (Fig. 8 b); (c) nodose-septate, narrow, much branched hyphae, thin-walled at first but becoming solid later, 0.7 — 1.5μ arising from normal thin-walled hyphae (Fig 8g); (d) oidia numerous or rare, cylindrical, thin-walled, hyaline 2.0 — 3.0μ in diameter and length variable (Fig. 8 h).

Fructifications: (a) thin-walled nodose-septate hyphae as in the advancing zone; (b) fibre hyphae numerous, long, unbranched, tortuous, yellowish-brown, walls thickened, lumina narrow or occluded, widening near the origins and tips, aseptate, 2.2 — 3.5μ (Fig. 8 b); (c) nodose-septate hyphae with pale-yellowish conspicuous walls, much branched and forming H-connections, 2.2 — 3.5μ in diameter, intertwined with other hyphae in the fructification (Fig. 8 c); (d) basidia hyaline, long-clavate to almost cylindrical 19.0 — 27.0 x 6.0 — 7.5μ, with 4 long, slender, straight sterigmata 4.5 — 6.0μ, borne in clusters of short branches from thin-walled, nodose-septate hyphae (Fig. 8 d); (e) basidiospores hyaline, cylindrical, obliquely apiculate, smooth, thin-walled 7.2 — 9.6 — (12) x 3.0 — 3.7μ (Fig. 8 e); (f) cystidioles hyaline, fusiform, often with peculiar branching, apical processes, 18.0 — 32.0 x 4.0 — 6.0μ arising from the basidial fascicles (Fig. 8 f).

Submerged mycelium: (a) hyphae hyaline, narrow, branched, with conspicuous clamp connections at the septa, thin-walled at first but walls thickening later, 1.2 — 2.0μ in diameter (Fig. 7d, 8k); (b) nodose-septate hyphae as in the advancing zone; (c) chlamydospores hyaline, ovoid to ellipsoid, thick-walled with deeply staining contents 10.0 — 23.0 x 6.0 — 10.0μ, intercalary or terminal (Fig. 8 m).

Carpophore characters

Carpophore annual or occasionally reviving, lignicolous, solitary or compound, sessile or effused-reflexed, applanate or dimidiate somewhat convex, often laterally connate, occasionally imbricate; coriaceous when fresh but harder and more rigid on drying, 1.0 — 10 x 1 — 4 x 0.2 — 0.8 cm; upper surface tomentose, velvety but becoming glabrous and rugose, azonate or concentrically sulcate, grayish-brown to cinnamon-brown or umber-brown; margin obtuse, thin, concolorous with pileus or somewhat paler, entire or somewhat lobed; pore surface concolorous or slightly paler than upper surface, lenzitoid to poroid or occasionally lamellate; tubes 1 — 4 mm deep, edges thin, entire, 2 — 3/mm; context fibrous, umber-brown, 1 — 4 mm thick.

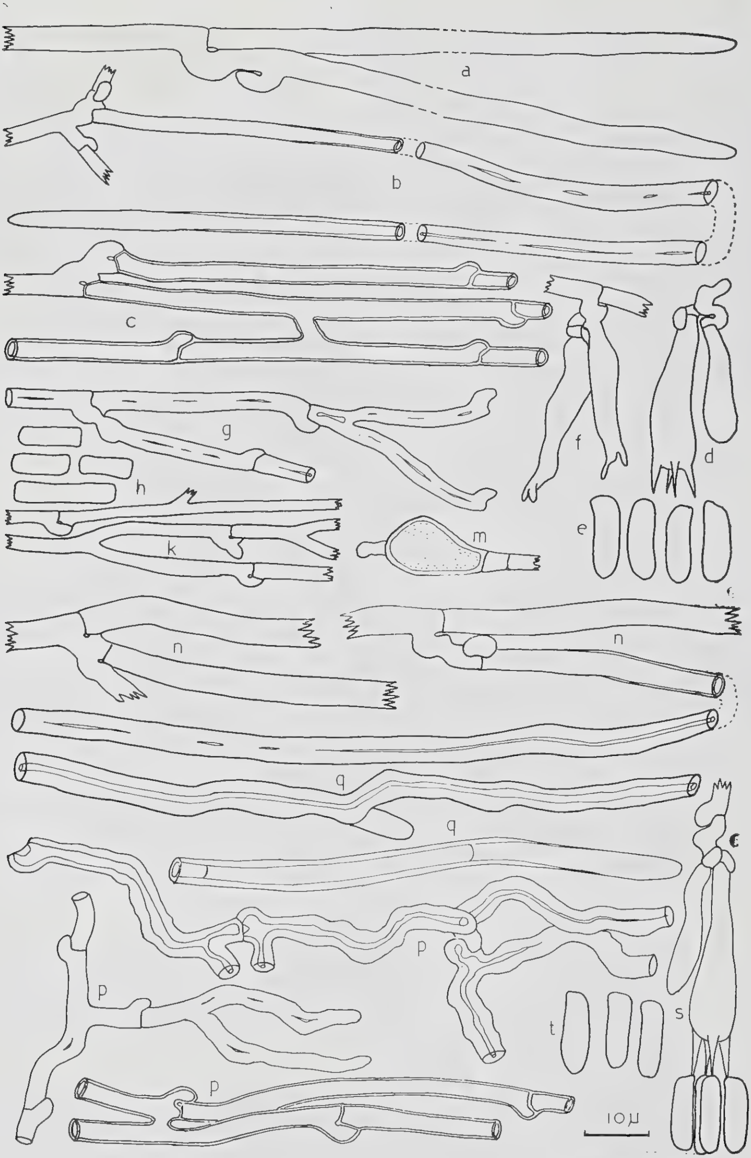

FIG. 8. — **Lenzites trabea.** a - m. Hyphae and structures from cultures: (a) hyphae from advancing zone; (b) unbranched, fibre hyphae; (c) thick-walled, nodose-septate hyphae with H-connection; (d) basidia; (e) basidiospores; (f) branched cystidioles; (g) thick-walled, sub-solid, nodose-septate hyphae; (h) oidia; (k) narrow, hyaline, nodose-septate, submerged hyphae; (m) chlamydospores.
n - t. Hyphae and structures from carpophores: (n) thin-walled, nodose-septate hyphae; (p) thick-walled, nodose-septate hyphae with tortuous branches; (q) unbranched fibre hyphae; (s) basidia; (t) basidiospores.

Hyphal characters. Carpophores consist of: (1) nodose-septate hyphae, thin-walled, hyaline, branching, often from the clamp connections, 2.4 — 4.0μ in diameter (Fig. 8 n); (2) nodose-septate hyphae with thickened sub-hyaline to brownish walls, narrowed or occluded lumina, branching and forming H-connections and forming short, tortuous, thin-walled or thick-walled to solid, nodose-septate, lateral branches 2.5 — 4.5μ in diameter (Fig. 8 p); (3) fibre hyphae long, straight or slightly flexuous, unbranched, pale brown, walls thickened, lumina narrow or occluded and usually widening towards the tip, aseptate, or with one or two simple septa towards the tip, 2.5 — 5.0μ in diameter (Fig. 8 q).

Hymenium: basidia long clavate, hyaline, 19.0 — 27.0 x 6.0 — 7.5μ, with four slender, straight sterigmata 4.5 — 6.0μ long (Fig. 8 s); basidiospores cylindrical, ends rounded, obliquely apiculate, hyaline, at first, later pale yellowish-brown, smooth ,thin-walled, 8.0 — 9.6 x 3.0 — 4.0μ (Fig. 8 t).

Construction. At the margin the carpophore consists of long, unbranched fibre hyphae with pale brown thickened walls and prominent aseptate lumina, subsolid in the middle portion, 2.4 — 3.6μ in diameter and arranged more or less parallel but somewhat intertwined in the direction of growth. Also intertwined with the fibre hyphae are long, hyaline, thin-walled, nodose-septate hyphae mostly branching from the clamp connections, 2.4 — 3.6μ in diameter, the branches interwoven with the other hyphae. In the context behind the margin the hyphae turn upward towards the upper surface. The fibre hyphae are lightly intertwined and similar to those of the margin but their lumina are narrower, often occluded and one or two simple septa may be present near their tips. Their ends are free and project upward to a common level to form the finely tomentose upper surface of the young parts of the pileus. Intertwined with these fibre hyphae, up to a position slightly below their tips, are numerous hyaline, nodose-septate hyphae similar to those in the margin, branching freely and forming frequent H-connections. In the older parts of the context the fibre hyphae are slightly darker in colour and their walls thickened for longer distances. Here the nodose-septate hyphae have thickened, pale brown walls with lumina narrowed and sections often solid and forming short, very tortuous, nodose-septate branches, tightly interwoven with the fibre hyphae (Fig. 8 p). In some specimens a greyish, glabrous cuticle may be present over this part of the carpophore. This may be up to 50μ thick and consists of hyaline or sub-hyaline hyphae with thick, gelatinous walls swelling in KOH, arising from the nodose-septate hyphae of the context, and lying prostrate and intertwined in all directions on the upper surface where they are agglutinated into a thin, smooth trichocutis (Lohwag, 1940). In the lower context the hyphae turn downwards into the trama Fibre hyphae resemble those of the upper context but they are narrower, mostly with very narrow lumina, more flexuous and tightly intertwined to form a denser tissue. In these parts, the nodose-septate hphae are thin-walled, hyaline, branching freely and interwoven with the fibre hyphae. Many branches of these nodose-septate hyphae are tightly intertwined with the fibre hyphae, become thick-walled or solid and bind the hyphal elements together into a tough tisue (Fig. 8 p). Many of these nodose-septate hyphae remain thin-walled and ramify though the hyphal elements in the tramal tissue to form numerous, short branches bearing clusters of basidia at the hymenial surfaces, each basidium subtended by a basal clamp connection (Fig. 8 s).

Decay and hosts

Lenzites trabea causes a brown rot of hardwood timbers but is also found on coniferous wood.

Specimens examined

Herb. DAOM: *F3823, on hardwood log, Ottawa, Ont., May 1934; F3838, on coniferous wood, St. Andrews, N.B., Aug. 1933; F3893, on *Acer* sp., Durham, Ont., Aug. 1937; F6482, on *Alnus incana,* Montgomery Lake, Ont., Sept. 1935; F8893, on *Acer* sp. log, near Durham, Ont., Aug. 1937; F9073, Mt. Mitutoge, Japan, Oct. 1933; *9507, on *Tsuga canadensis,* Toronto, Ont., 1939; *22444, on deciduous log, Waterbury Centre, Vt., Oct. 1950; *22630, ex Div. For. Prod. South Melbourne, Aust., 1939; *30929, on *Pinus sylvestris,* Suomsujorri Lieksa, Finland, 1951; *72285, Portage du Fort, Que., June 1961.
Herb. PRE: 31310; 31341, decayed wood, Stellenbosch, C.P., Nov. 1926; 31379, old posts, Stellenbosch, C.P., Aug. 1919; 31426, decaying logs, Stellenbosch, C.P., Sept. 1919; 36818, on *Pinus* sp. stumps, Harrismith, O.F.S., March 1948; 40222, on *Cupressus* sp. logs, Pretoria, Tvl., March 1952; 41679, Johannesburg, Tvl., 1954; *42457, on decaying hardwood log, Honeydew, Tvl., Jan. 1961.

Interfertility studies

Lenzites trabea has the bipolar type of interfertility with allelomorhps for heterothallism at one locus only (Mounce & Macrae, 1936). To determine whether the South African collection was interfertile and therefore conspecific with a Canadian strain, four cultures, each obtained from a single basidiospore of PRE 42457, were mated on malt agar slants in all possible combinations with each of four single spore cultures of the Canadian isolate DAOM 72285. The results are given in TABLE 4.

The formation of clamp connections on all the paired mycelia is regarded as positive proof that the South African and Canadian isolates are interfertile and therefore conspecific.

Discussion

This description of the cultural characters of *Lenzites trabea* agrees well with those of Snell (1922), Cartwright (1931), Cartwright & Findlay (1946) and Nobles (1948). Cultures of this species are readily recognized by their distinctive colour and texture, early fruiting, the brown fibre hyphae which are rare in the mycelial mat but abundant in the fruiting structures, and the very narrow hyphae with large conspicuous clamp connections which are found at the surface of the agar (Fig. 7 d).

From the descriptions it is evident that not all structures formed in culture are also present in the carpophores. The narrow hyphae with prominent clamp connections as well as the chlamydospores formed in the agar were not found in the carpophores. It is possible that these structures may be found in the wood decayed by the fungus but no specimens of decayed wood were available for examination. Chlamydospores have been found in wood decayed by species which form them in culture (Cartwright & Findlay, 1946). The nodose-septate hyphae and fibre hyphae formed in cultures are similar to those in the carpophores of *Lenzites trabea.*

From the above description it is evident that the carpophores of *Lenzites trabea* consist of two types of hyphae only, viz. unbranched, thick-walled hyphae mostly aseptate or occasionally with one or two simple septa (skeletal hyphae, Corner, 1932 a) and branching, nodose-septate hyphae either with thin, hyaline walls or with the walls coloured and thickened (sclerified generative hyphae, Donk, 1964). This observation agrees with the descriptions of the hyphae of this species by Pinto-Lopes (1952), Teston (1953 b) and Overholts (1953). According to the definitions of Corner (1932 a, 1953), Cunningham (1946, 1954) and Teixeira (1962 b) hyphae with clamp connections must be regarded as generative hyphae. The carpophore of *Lenzites trabea* thus has a dimitic hyphal system. But thick-walled elements of the nodose-septate hyphal system serve to bind the tissues of

the carpophores. This binding hyphal system, which admittedly is not well developed, thus consists of sclerified generative hyphae. The carpophores of *Lenzites trabea* differ in construction and hyphal characters from those of *Lenzites sepiaria*, a species with trimitic hyphal system (Cunningham, 1948 h; Teston, 1953 b) in which the binding system consists of "branched, aseptate, thick-walled hyphae of limited growth" that arise as differentiated terminal cells of lateral branches of nodose-septate generative hyphae (Corner, 1932 a). This difference is of fundamental importance in the anatomy of the carpophores of these two species, which therefore cannot be regarded as being congeneric.

Pinto-Lopes (1952), Corner (1954 a), Bondartseva (1961), Teixeira (1962 b) and Donk (1964) regard the absence or presence of different types of hyphae in carpophores as important at the generic or higher level. *Lenzites trabea* thus cannot be regarded as being congeric with *Lenzites sepiaria*, the type species of the genus *Gloeophyllum* Karsten (Cooke, 1959; Donk, 1960). For this same reason, *Lenzites trabea* cannot be congeric with any one of the three species *Polyporus occidentalis*, the type species of the genus *Coriolopsis* Murr., or *Lenzites betulina*, the type species of the genus *Lenzites* Fr., or *Trametes sauveolens*, the type species of the genus *Trametes* Fr. *Lenzites trabea* had been transferred to each of these three genera by various authors (loc. cit.) of which all have fruit bodies with trimitic hyphal systems (see descriptions Group 45).

Fries (1821) and Cunningham (1948 h) regarded *Lenzites trabea* as congeneric with *Daedalea quercina* Fr., the type species of the genus *Daedalea* Fr. But the nodose-septate hyphae with irregularly thickened walls which are present in cultures and carpophores of that species (Group 25) are not present in the cultures and fruit-bodies of *Lenzites trabea* and the two species can therefore not be regarded as congeneric.

Kotlaba & Pouzar (1957) created the new genus *Phaeocoriolellus* with *Lenzites trabea* as the type and only species. This genus is characterized by a dimitic hyphal system and was based on Bondartsev's (1953) and Teston's (1953 b) descriptions.

M. E. P. K. Fidalgo (1962) reported that hyphal analysis of *Trametes odorata* (Wulf. ex Fr.) Fries, the type species of the genus *Osmoporus* Sing., revealed this fungus to be dimitic, with the generative hyphae branched, hyaline, nodose-septate, characteristically thin-walled but often thick-walled or solid and skeletal hyphae unbranched, yellowish-brown to brown, aseptate, long, fibre-like. The nodose-septate hyphae were thin-walled in the growing region but often thick-walled and brownish in the older parts of the context and above the dissepiments. Fidalgo's descriptions of the hyphae, which confirmed the reports of Pinto-Lopes (1952) and Teston (1953 b), agree very closely with the description of the hyphae of *Lenzites trabea* as given above. These two species are thus very similar in hyphal characters, construction of the carpophore and other morphological features. These two species are thus congeneric and if the genus *Osmoporus* Sing. is accepted as valid, *Lenzites trabea* should be transferred to it.

Resumé.

From these descriptions it is evident that *Lenzites sepiaria* (Wulf. ex Fr.) Fr. and *Lenzites trabea* Pers. ex Fr. possess many characters which are common to both species in their cultures and their carpophores. The absence of some types of hyphae, which are present in the carpophores of *Lenzites sepiaria*, from carpophores of *Lenzites trabea*, indicates that the relationship between these species, which is suggested by these common characters, must exist at a supra-generic level.

5.4 Group 18

The mycelial mats of cultures of species in this group usually remain white or may develop pale pinkish or vinaceous tints. They do not produce extra-cellular oxidase. Their thin-walled hyphae have simple clamp connections at the septa and remain thin-walled but septate, thick-walled fibre hyphae are also formed in large numbers. Their basidiospores are globose, ovoid or ellipsoidal in shape. The interfertility of species of which this character is known, is of the bipolar type.

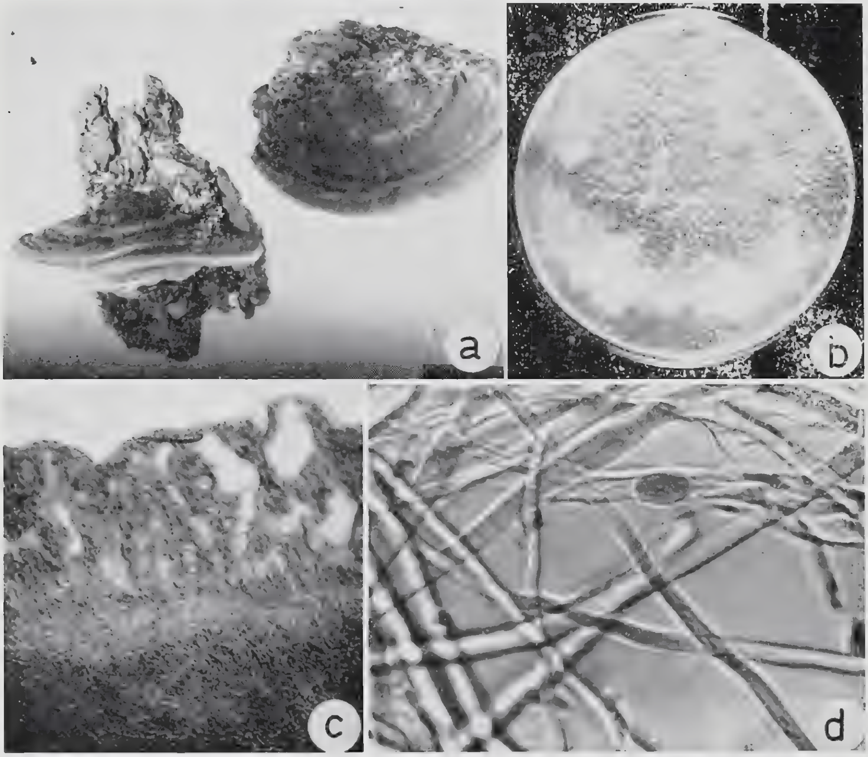

Fig. 9.—**Fomes pinicola.** (a) Carpophores of DAOM 22755; (b) culture at six weeks; (c) upper context and crust of fruit-body in radial-longitudinal section, × 100, in KOH; (d) inter-calary chlamydospore, thin-walled nodose-septate hyphae and fibre hyphae from carpophore.

Fomes pinicola *(Sw. ex Fr.) Cooke,* Grev. 14, 17, 1885;

Polyporus pinicola Sw. ex Fr., Syst. Myc. 1, 372, 1821;

Fomitopsis pinicola (Sw. ex Fr.) Karst., Bidr. Kanned. Finl. Nat. Folk, 48, 306, 1889.

Ungulina marginata (Fr.) Pat., Essai taxon. Hymen., p. 103, 1900.

Cultural characters

Growth is moderately fast to slow, the plates being covered in four to six weeks. Advancing zone even at first, thin, downy, appressed, later somewhat ragged but the mat becoming more dense towards the inoculum; white, raised, cottony-woolly, concentric zones develop or rounded lumps or nodules which slowly increase in size, appear on the zones of denser mycelium and may grow together as compact, uneven masses of tough, chamois mycelium near the sides of the plate; fruiting areas originating as shallow pores of which the sides grow upward to form tubes, resulting in pored areas with the oldest tubes in the centre, develop on the irregular lumps after five to six weeks. The cultures remain white or pale "cream color" over the fruiting areas. The reverse remains unchanged. No odour or a faint, fragrant odour is emitted. No colour change occurs when alcoholic gum guaiac is applied to the culture. No diffusion zones are produced on gallic acid and tannic acid media but some mycelial growth occurs on both media.

Advancing mycelium: hyphae branching at or near the septa, hyaline, thin-walled, nodose-septate, 1.0 — 4.0μ in diameter (Fig. 10 a).

Aerial mycelium: (a) nodose-septate hyphae as in the advancing zone; (b) fibre hyphae hyaline, long, unbranched or occasionally branched, arising from nodose-septate hyphae, thin-walled near their origins and tips but walls thickened, lumina narrow or occluded, aseptate or with one septum near the tip, 1.0 — 4.0μ in diameter (Fig. 10 b); (c) chlamydospores, inter-calary or terminal, ovoid to sub-globose with thickened walls 6.0 — 18.0 x 6.0 — 9.0μ, mostly in young parts of mycelium (Fig. 10 c).

Fructification: (a) hyphae as in the advancing zone; (b) fibre hyphae as in the aerial mycelium but more freely branched, the branches long and tortuous, a number of branches often arising close together from a main branch and close to its origin, 1.0 — 4.0μ in diameter (Fig. 10 d); (c) basidia long clavate, 18.0 — 25.0 x 5.5 — 7.2μ with four sterigmata 2.4 — 3.0, and arising from short branches of thin-walled, nodose-septate hyphae in the dissepiments (Fig. 10 e); (d) basidio-spores hyaline, ovoid, or ellipsoidal with an oblique apiculum, thin-walled, smooth 4.8 — 6.0 x 3.3 — 4.0μ (Fig. 10 f); (e) hymenial cystidia hyaline, long cylindrical often tapering towards the tips and projecting somewhat beyond the basidia, 24.0 — 30.0 x 2.4 — 3.0μ, arising from the basidial fascicles (Fig. 10 g).

Carpophore characters

Carpophore perennial, lignicolous, solitary, sessile, dimidiate, convex to ungulate, hard corky to woody up to 15 x 20 x 10 cm; upper surface covered with a resinous layer, smooth, sticky and reddish brown at first, later dark gray to black, smooth or sulcate with age, hard; margin obtuse, thick, rounded, entire to lobate or undulate, pallid or lighter coloured than other areas; pore surface white to yellowish or pale buff where bruised; pores, rounded, 3 — 5 per mm, mouths entire, dissepiments thick, even; tubes concolourous, distinctly stratified, 3 — 7 mm long each season; context pale creamy to yellowish or pale brown, concentrically zoned, reddish brown in KOH, up to 2.0 cm thick.

Hyphal characters: carpohores consist of (a) hyaline, branching, thin-walled, nodose-septate hyphae, with deeply staining contents, or empty, 2.2 — 4.0μ in diameter, (Fig. 10 h); (b) fibre hyphae long, unbranched, hyaline to sub-hyaline with walls thick and refractive, lumina narrow, widening gradually towards the ends, aseptate or with one or two simple septa near the distal end, 3.0 — 9.0μ in diameter (Fig. 10 k); (c) chlamydospores hyaline, ovoid to ellipsoid, thick-walled, intercalary in nodose-septate hyphae, 7 — 12 x 10 — 24μ (Fig. 10 m).

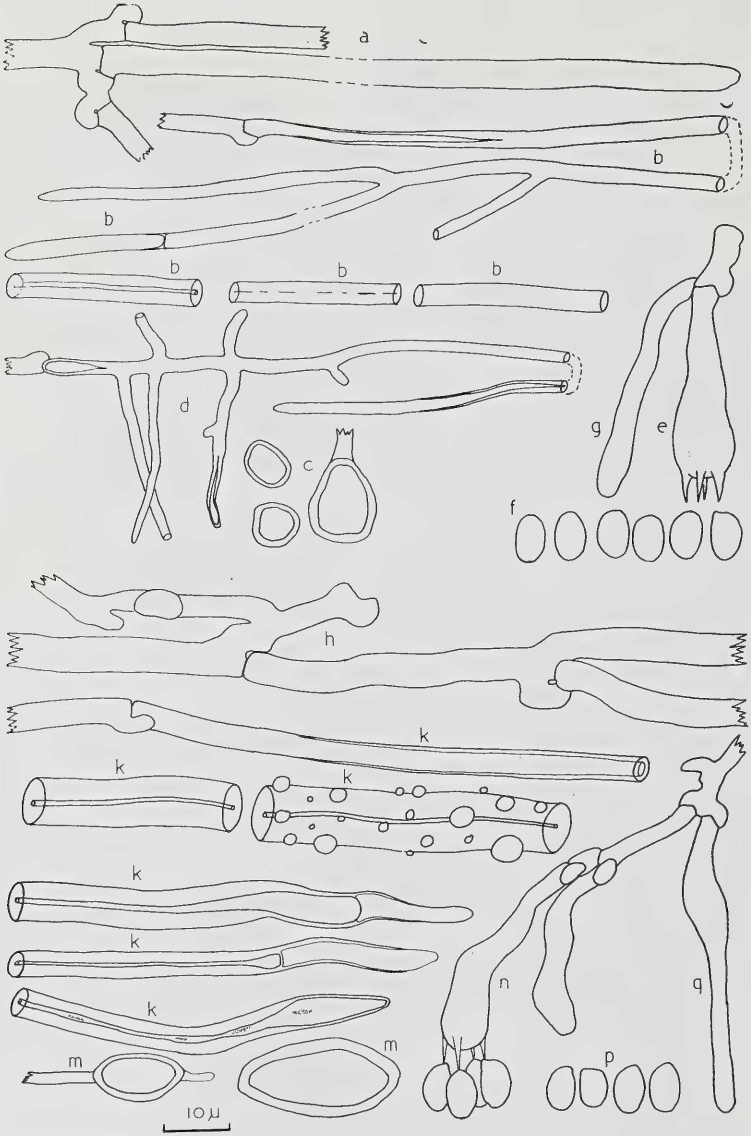

FIGURE 10.

FIG. 10.—**Fomes pinicola.** a - f. Structures from culture: (a) nodose-septate hyphae from advancing zone; (b) fibre hyphae; (c) chlamydospores; (d) fibre hyphae with long, tapering branches; (e) basidia; (f) basidiospores; (g) hymenial cystidium.

h - q. Structures from carpophores: (h) thin-walled, nodose-septate hyphae; (k) fibre hyphae; (m) chlamydospores; (n) basidia; (p) basidiospores; (q) hymenial cystidium.

Hymenium: basidia hyaline, long clavate 18.0 — 25.0 x 5.5 — 7.2μ with four slender, straight sterigmata 2.4 — 3.0μ (Fig. 10 n); basidiospores hyaline, ellipsoidal to ovoid, smooth, thin-walled, 4.8 — 6.0 x 3.3 — 4.0μ (Fig. 10 p); hymenial cystidia long, hyaline, tapering terminally, 24 — 30 x 2.4 — 3.0μ, projecting 10 — 12μ beyond the basidia (Fig. 10 q).

Construction: At the margin the carpophore consists of long, unbranched, thick-walled, fibre hyphae with narrowed lumina, arranged parallel to the direction of growth of the carpophore, somewhat intertwined and closely packed. Behind the margin in the context are numerous hyaline, thin-walled, nodose-septate hyphae, branching repeatedly and intertwined with the fibre hyphae, which arise from them. The context consists of long fibre hyphae, unbranched or occasionally branched, hyaline or sub-hyaline, sub-solid to solid, aseptate or occasionally with one or two simple septa at the distal end, 3.0 — 9.0μ in diameter and with globules of lacquer-like material adhering to them in the zones of growth of the pileus. These hyphae are mostly closely packed and slightly intertwined among themselves and with branching, hyaline, thin-walled, nodose-septate hyphae, some with deeply staining contents, others collapsed and empty, or, with intercalary thick-walled, ovoid to ellipsoid chlamydospores 7 — 12 x 10 — 24μ in the middle and lower context. At the upper surface the ends of fibre hyphae are bent over and become interwoven with one another and numerous branching, thin-walled, nodose-septate hyphae with deeply-staining contents, to form a sub-surface cortex (Lohwag, 1940). From these hyphae, a resin-like material is exuded which permeates the upper layer of the cortex and covers the surface of the pileus in a layer up to 1500μ thick (Fig. 9 c). From the lower context the fibre hyphae bend downward, remaining unbranched and intertwined towards the dissepiments. In the dissepiments the fibre hyphae are unbranched, tortuous, sub-solid, aseptate, narrower than in the context and tightly intertwined among themselves. Hyaline, nodose-septate hyphae are intertwined and interwoven with the fibre hyphae, branching freely and becoming increasingly numerous towards the hymenial surfaces where short branches project to bear fascicles of clavate basidia and long, tapering cystidia.

Decay and hosts

Fomes pinicola causes a brown rot of dead, standing or fallen coniferous and occasionally angiosperm timber, destroying both heartwood and sapwood.

Specimens examined

Herb. DAOM: *F3249, on *Populus balsamifera,* Victoria Beach, Man. May 1933; *F6895, on *Pinus yezoensis,* Hokkaido, Japan; *F6925, on *Picea glauca,* Hot Springs, Alaska, Aug. 1936; *F7120, on fallen *Picea exelsa,* Poland, Sept. 1936; *7121, on living *Prunus avium,* Poland, Sept. 1936; *8567, on *Picea sitchensis,* Kodiak Is., Alaska, Aug. 1938; *8568, on *Tsuga heterophylla,* Mt. Arrowsmith; *9937, on dead *A. saccharum,* Preston, Ont., Oct. 1959; *10787, on *Pyrus malus* stump, Kentville, N.S., Feb. 1942; 17924, on *Picea glauca,* Hudson Bay, Sask., Sept. 1947; 17926, on *Populus tremuloides,* Hudson Bay, Sask., Sept. 1947; 22358, ex Herb. J. Pinto-Lopes, Lisbon; 22711, on *Abies balsamea* log, Labrador, Aug. 1949; 22746, on *Picea* sp. logs, Moosehide Mtns., Yukon, Aug. 1949; 30023, on *Betula papyrifera,* Doré Lake, Sask., July 1948; 30064, on *Pinus contorta* slash, Spines Mill, Alta., Sept. 1950; 30152, on *Betula alba,* Uppsala, Sweden, Aug. 1952; 30157, *on Betula alba,* Uppsala, Sweden, Sept. 1952.

Discussion

The cultural characters as described above agree well with those described by Mounce (1929), Campbell (1938), Davidson, Campbell & Vaughn (1942), Cartwright & Findlay (1946) and Nobles (1948, 1965). There is a decided lack of distinguishing features in the gross appearance and hyphal characters of the mat formed in culture but the chlamydospores which occur in the newer parts of the mat but not in the older parts, may be a useful diagnostic feature.

From the above description it is clear that only thin-walled, branching nodose-septate hyphae and fibre hyphae, typically unbranched, are present in the carpophores. Lowe (1957) stated of *Fomes pinicola:* "context hyphae rarely branched, thick-walled, non-septate, 5 — 8μ in diameter with a small amount of thin-walled, clamped hyphae, 2.4μ in diameter; tramal hyphae similar except mostly 3 — 5μ in diameter". Overholts (1953) reported the thick-walled, aseptate hyphae but also found "hyphal complexes composed of hyaline hyphae 3 — 4μ in diameter, present in considerable numbers". Overholts usually reported such hyphal complexes in species in which branched binding hyphae are present (e.g. *Lenzites betulina).* Overholts did not describe the hyphae in these complexes. Teston (1953 b) figured narrow, thick-walled branched hyphae from the tubes of *Ungulina marginatus* (=*Fomes pinicola,* Bourdot & Galzin, 1928; Lowe, 1957) but stated that a few branched hyphae are found in the dissepiments of the carpophores of this species. No anatomical details of these hyphae were given however. It appears that Overholts' "hyphal complexes" and Teston's "branching hyphae" may correspond to the branched, nodose-septate hyphae, some of which have thickened walls, which are very numerous in the dissepiments of the specimens examined of this species. Structures resembling binding hyphae as described and defined by Corner (1932 a, 1953), Cunningham (1946, 1954), and Teixeira (1962 a, b) were never seen in any of the specimens examined. The above description thus agrees well with earlier reports on the hyphal characters of this species.

From the descriptions it is clear that structures found in the cultures, are also found in the carpophores. While the fibre hyphae of the carpophores are mostly unbranched, branched fibre hyphae are found in the fruiting areas formed in culture. The number of branches is however the only difference between these structures which are otherwise identical in all other respects. The chlamydospores found in some of the carpophores examined, are of interest since their occurrence in carpophores of Hymenomycetes have been reported only rarely, even in species in which they are abundantly produced in cultures. This is an indication that the absence or presence of chlamydospores in cultures, is at best of diagnostic value in the identification of cultures only.

Fomes pinicola has the hyphal characters, which are typical of species with the dimitic hyphal system as described by Corner (1932 a, 1953) and Cunningham (1946, 1954). Farinha (1964) reached a similar conclusion after a study of cultures and carpophores of this species. The large, perennial carpophores are however remarkably simple in construction. The fibre hyphae are straight and are more or less parallel to one another in the carpophore. Even in the dissepiments are they seldom very tortuous, suggesting a rather loose association of hyphae. There further appears to be little binding of the tissues by the nodose-septate hyphae as observed in *Lenzites trabea* and special binding hyphae or processes are lacking. This simplicity of construction is emphasized by the fact that sections of the carpophores, even from the dissepiments, are easily teased out with needles or even squashed when placed in KOH for microscopic examination.

The simple construction and dimitic hyphal system of fruit-bodies of *Fomes pinicola,* are in sharp contrast to the complex carpophores of *Fomes fomentarius* (L. ex Fr.) Kickx the type of the genus *Fomes* (Fr.) Kickx (Donk, 1960) as described by Teixeira (1962 a). According to Teixeira (1962 a), the fruit-bodies of *Fomes fomentarius* are characterized by the dark brown context, consisting of nodose-septate generative hyphae, dark-brown, thick-walled skeletal hyphae and much branched binding hyphae and are covered by an indurate layer of agglutinated ends of skeletal hyphae. Because of this great difference in hyphal composition

and construction of the carpophores of *Fomes fomentarius* and *Fomes pinicola*, these two species cannot be regarded as congeric.

Although *Fomes fomentarius* (L. ex Fr.) Kickx is the type species of the genus *Fomes* (Fries) Kickx, Donk (1960) presented strong evidence in favour of his view that this species is also the type of the genus *Ungulina* Pat. and that the latter genus is an isonym of the genus *Fomes* (Fr.) Kickx. If this view is accepted, it will mean that *Fomes pinicola* cannot be included in either of the genera *Fomes* (Fr.) Kickx or *Ungulina* Pat. but may be best placed in the genus *Fomitopsis* Karsten of which it is the type species (Cooke, 1959; Donk, 1960).

Fomes pinicola has not been recorded from South Africa. The species however occupies an important taxonomic position as the type of the genus *Fomitopsis* Karst., to which a number of species, including some found in South Africa, had been referred. It furthermore appeared to be a good example of a species with dimitic hyphal system, of which the construction had not been described, to include in this study in order to have a sound basis for future comparison with possibly related species.

5.5 Group 25

Cultures of species in this group form white, pale yellow or rose coloured mycelial mats which do not produce extra-cellular oxidase enzymes. Their thin-walled hyphae have simple clamp connections at the septa. Thick-walled, aseptate fibre hyphae are also formed. Characteristic hyphae with numerous clamp connections and their walls irregularly thickened, and the lumina much reduced but staining deeply in phloxine, are present to a greater or lesser extent. Their basidiospores are cylindrical or allantoid. Their interfertility, where known, is of the bipolar type.

Daedalea quercina *L. ex Fr.*, Syst. Myc. 1, 333, 1821;

Lenzites quercina (L. ex Fr.) Quélet, Ench., 153, 1886;

Trametes quercina (L. ex Fr.) Pilát, Atl. Champ. Eur. 3, 329, 1936.

Cultural characters

Growth is slow, the mat reaching a radius of about 30 mm in two weeks and covering the plate only after six weeks. The advancing margin is even with the hyphae raised to the limit of growth. The mat is white, at first woolly with fine strands radiating from the inoculum. From 3 — 4 weeks the older mycelium tends to become appressed and patches of denser felty mycelium with an overgrowth of sparse, erect, cottony mycelium begin to form on the agar in the older parts of the mat and along the sides of the dish. Over these patches, fruiting areas may appear as granules which later develop into coarse, warty or spine-like columns of dense white or creamy mycelium which may become connected to each other by ridges or strands of similar dense mycelium. At six weeks the cultures have a thin, radiating, woolly mat with vague, radiating and concentric depressions with the dense mycelium of the fruiting areas mostly over the older parts and against the sides of the dish. Rhizomorphic strands may run from the inoculum to the fruiting areas. The reverse remains unchanged. At 4 — 6 weeks a pleasant, fruity odour is given off by the culture. No reaction is evident when tested for extra-cellular oxidase enzymes with gum guaiac solution.

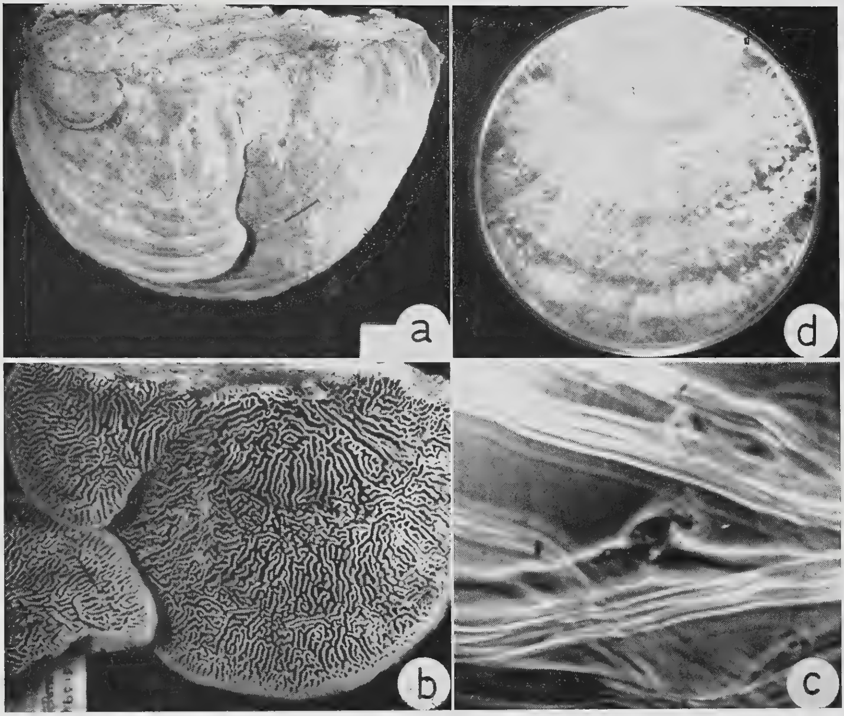

FIG. 11.— **Daedalea quercina.** (a) Carpophore of PRE 31394, upper surface and (b) hymenial surface; (c) nodose-septate hyphae with irregularly thickened walls from carpophore, × 1000; (d) culture of PRE 42366 at 6 weeks.

Advancing mycelium: hyphae hyaline, thin-walled, nodose-septate, branching at or near the septa or from clamp connections 2 — 6μ in diameter (Fig. 12 a).

Aerial mycelium: (a) nodose-septate hyphae as is the advancing zone; (b) nodose-septate hyphae with the walls irregularly thickened and with deeply staining contents in the lumina, either very narrow 1.5 — 2.0μ in diameter, branching and solid in parts or wide, up to 6μ in diameter and mostly unbranched and tending to break at the clamp connections (Fig. 12 b). The latter type is abundant in the felty mycelium on the surface of the agar; (c) fibre hyphae hyaline, unbranched or occasionally with branches, the walls thick, refractive and lumina narrow or almost occluded, aseptate and widening only at the ends, 1.5 — 4.0μ in diameter (Fig. 12 c). They arise from thin-walled, nodose-septate hyphae and nodose-septate hyphae with irregularly thickened walls.

Fructifications: (a) nodose-septate, thin-walled hyphae; (b) nodose-septate hyphae with irregularly thickened walls, and (c) fibre hyphae as described above. Basidia hyaline, long-clavate 22 — 36 x 4.5 — 6μ, with 4 straight sterigmata 3.6 — 4.5μ long (Fig. 12 d), borne in clusters on repeatedly branched thin-walled, nodose-septate hyphae (Fig. 12 d); basidiospores, short cylindrical, hyaline, smooth, thin-

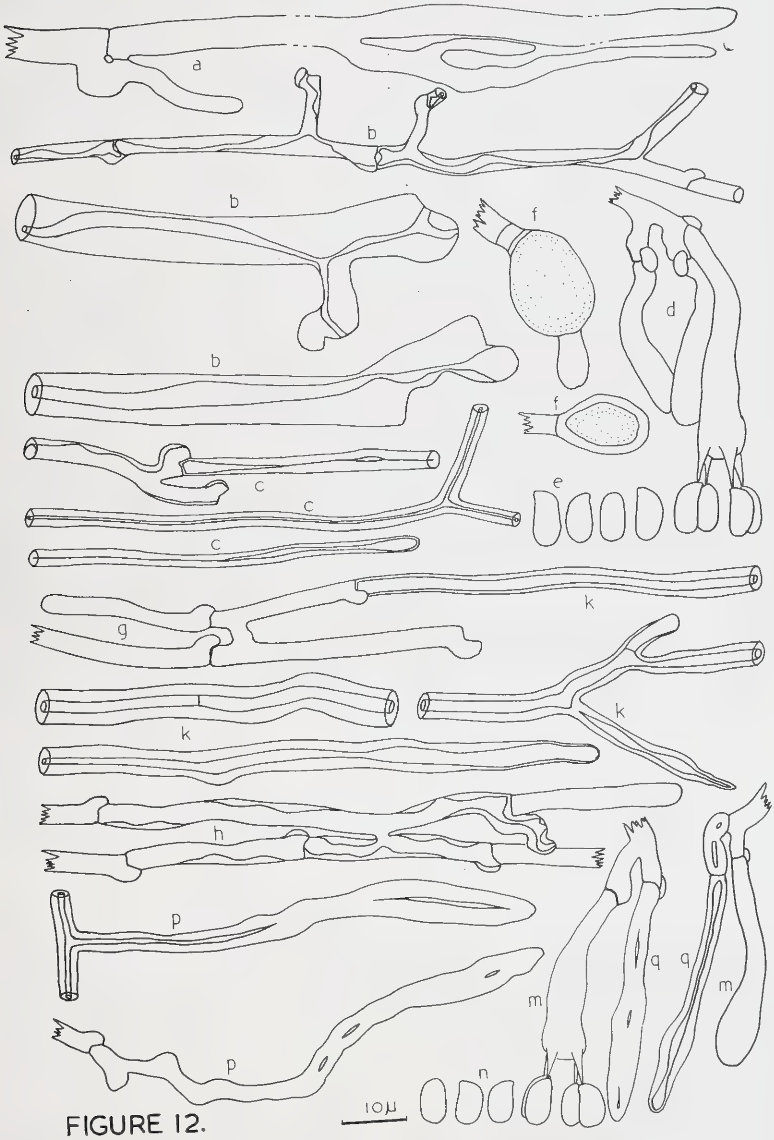

FIG. 12. — **Daedalea quercina.** a - f. Structures from culture: (a) hypha from advancing zone; (b) nodose-septate hyphae with irregularly thickened walls; (c) fibre hyphae; (d) basidia; (e) basidiospores; (f) chlamydospores.
g - q. Structures from carpophores: (g) thin-walled, nodose-septate hyphae; (h) nodose-septate hyphae with irregularly thickened walls; (k) fibre hyphae; (m) basidia; (n) basidiospores; (p) tramal cystidia; (q) skeletal cystidia.

walled, 4.5 — 6.5 x 2.4 — 3μ (Fig. 12 e). Ends of fibre hyphae project into the hymenium and slightly beyond it from the underlying tissues, appearing as hyaline cystidia, 3 — 3.6μ in diameter.

Submerged mycelium: (a) hyaline, thin-walled, nodose-septate hyphae as in the advancing zone; (b) nodose-septate hyphae with irregularly thickened walls as in the aerial mycelium; (c) chlamydospores intercalary and terminal, hyaline, ellipsoidal, thick-walled 6 — 20 x 4 — 8μ (Fig. 12 f).

Carpophore characters

Carpophores perennial, lignicolous, solitary or grouped, sessile, dimidiate; pileus applanate, occasionally connate, imbricate; hard corky or rigid up to 15 x 20 x 8 cm; upper surface at first finely tomentose, soon glabrous, uneven to zonate, somewhat furrowed, finally somewhat incrusted with age, at first whitish, later umbrinous to black; margin obtuse, entire, pallid; pore surface creamy white to pale amber or avellaneous, poroid at first but soon labyrinthiform and about 1 mm wide, dissepiments even, 0.75 — 1.5 mm wide; tubes up to 3 cm deep, somewhat decurrent, concolourous with the pore surface; context whitish to pale brown, 0.2 — 1.5 cm thick, corky, zonate, with concentric zones of darker and lighter colour, smooth, fibrous texture and darkening with KOH.

Hyphal characters: (i) thin-walled, nodose-septate hyphae hyaline, branched, with frequent H-connections, 1.8 — 3.0μ in diameter (Fig. 12 g); (ii) nodose-septate hyphae with irregularly thickened, refractive walls hyaline, branched, forming occasional H-connections and contents staining deeply in phloxine, 1.8 — 3.6μ in diameter, rare (Fig. 12 h); (iii) fibre hyphae long, more or less straight, or flexuous, unbranched, or, with one or two branches often with pointed ends sub-hyaline to pale brown, the walls thickened towards the middle with extremities thin-walled lumina prominent, staining, aseptate, or with one or two simple septa near the tips, widest at the ends, or, walls much thickened, with lumina narrowed or occluded and reduced to a thin interrupted line, expanding only towards the ends, 2.5 — 5.5μ in diameter (Fig. 12 k).

Hymenium: basidia long clavate 20.0 — 30.0 x 4.5 — 6.5μ bearing four short, slender, straight sterigmata 2.5 — 3.0μ (Fig. 12 m); basidiospores hyaline, long ellipsoid to cylindrical and flattened on one side, thin-walled, smooth 4.8 — 6.5 x 2.4 — 3.0μ (Fig. 12 n); tramal cystidia hyaline, ob-clavate, thick-walled to sub-solid 30.0 — 50.0 x 4.0 — 6.0μ or longer, arising in the hymenium or in the trama below (Fig. 12 p).

Construction. At the margin the fibre hyphae are mostly long, straight and unbranched with prominent lumina, their ends often thin-walled and collapsed. These hyphae are arranged more or less parallel to and loosely intertwined with each other and with the numerous branched, thin-walled, nodose-septate hyphae from which they arise. The older parts of the context are similar but the fibre hyphae have thicker walls, becoming sub-solid and few thin-walled, nodose-septate hyphae are present. In the upper part of the context the fibre hyphae bend upwards gradually, are mostly branched, sub-solid, up to 5.5μ in diameter more or less straight and loosely intertwined, and arranged with their apices closely packed and imbricate at a common level, to form the finely pubescent upper surface. Thin-walled, nodose-septate, branching, hyaline hyphae mostly 2.5μ in diameter are intertwined with the fibre hyphae just below the level of the upper surface. From the lower part of the margin and context, fibre hyphae turn downward towards the dissepiments. These fibre hyphae are narrower, mostly 2.2 — 4.0μ in diameter with more prominent lumina, often very tortuous and more frequently branched, the branches long and flexuous and becoming tightly interwoven in all

directions with each other and with the numerous nodose-septate hyphae into a denser and more compact tissue than the upper context. Some fibre hyphae remain more or less straight. Intertwined with the fibre hyphae are nodose-septate hyphae, mostly thin-walled but occasionally with their walls irregularly thickened and refractive, branching repeatedly and becoming increasingly numerous towards the surface of the dissepiments where they branch freely to form the numerous, short, closely packed, tightly intertwined, nodose-septate branches which bear the basidia. The ends of fibre hyphae from the trama of the dissepiments may protrude through this layer and beyond the basidia as tramal cystidia. Short fibre hyphae, 50.0 — 90.0μ in length, arising from thin-walled, nodose-septate hyphae in the trama, or, as lateral branches of fibre hyphae and mostly narrow, 1.8 — 2.2μ, near their origin and for part of their length, but then widening suddenly into spear-shaped ends (Fig. 12 p), may also project as skeletal-cystidia into the hymenium (Fig. 12 q). Thick-walled cystidia arise from the basidial fascicles on the same level as the basidia.

Decay and hosts

Daedalea quercina causes a brown rot of hardwood timber and trees where it lives saprophytically on dead parts (Cartwright & Findlay, 1946).

Specimens examined

Herb. DAOM: *F676, Quercus sp., Ottawa, Ont., Sept. 1926; *F2278, on red oak, Morton, Ont., June 1932; F6848, on hardwood stump, Mt. Burnet, Que., Nov. 1935; F6888, on*Quercus* sp., Chelsea, Que., Nov. 1935; F10198, on *Quercus* sp., Ile Perrot, Que., Aug. 1941; 17933, on *Quercus robur,* Bavaria, Sept. 1946; 22351, on *Eucalyptus* sp., Portugal, ex Herb J. Pinto-Lopes; 52788, on *Quercus borealis,* Wickham, New Brunswick; 53418, on *Quercus* sp., Gatineau, Que., Nov. 1950; 72046, Fungi Scandinaviae, Ellensvide, Sweden; *72510, Gatineau Park, Que., Oct. 1961.
Herb. PRE: 1480, Kirstenbosch, C.P., June 1921; 15552, on *Quercus* stump, ex Herb. L. O. Overholts; 22846, Falkenberg, Germany, Leg. Plogel; 24207, on *Quercus* sp. ex Hollos, Hungarian Fungi; 31394, Stellenbosch; 36573, on stump, Falcourt, Sussex, England, Aug. 1947; 34551, on *Quercus* sp., Cape Town; 41570, on *Eucalyptus* stump, ex Herb. J. Pinto-Lopes; *42366, on decayed hardwood, Pakenham, Ont., Aug. 1962.
Herb. STE: 1397, Kirstenbosch, C.P.; 1674, Kirstenbosch, C.P., July 1924; 2521, Kirstenbosch, C.P., June 1928; 2742, East London, C.P., Sept. 1932.

Discussion

In the cultures, fibre hyphae are present mainly in the tough, felty, fertile areas. On the other hand, the nodose-septate hyphae with irregularly thickened walls, which are so characteristic of cultures of this group, are not very numerous in the fertile parts of the culture. Instead, these hyphae make up a large proportion of the soft aerial mycelium where they may develop into solid hyphae with solid clamp connections.

This description of the cultural characters agrees well with those of Humphrey & Siggers (1933), Cartwright & Findlay (1946) and Nobles (1948) but the thin-walled swollen, globose cells, either single or in chains, usually "common in fragile, cinnamon-buff mycelium from the upper part of the culture in test tube cultures 6 — 8 weeks old", reported by Davidson *et al.* (1942) were not seen.

From the descriptions it is evident that three kinds of hyphae are present in carpophores of *Daedalea quercina,* viz.: nodose-septate hyphae with thin walls, nodose-septate hyphae with irregularly thickened walls and fibre hyphae which are mostly unbranched. The carpophores also possess extra-hymenial structures but are on the whole rather simple in construction despite their usual large size.

Thin-walled, nodose-septate hyphae have been reported in the carpophores of *Daedalea quercina* by Cunningham (1948 h), Pinto-Lopes & Farinha (1950).

Pinto-Lopes (1952), Overholts (1953), Teston (1953 b) and Teixeira (1960). The nodose-septate hyphae with irregularly thickened walls have been reported from cultures only by Nobles (1948, 1958 b), but these hyphae, which are so abundant in the cultures have not been reported form the carpophores before. They are present in the carpophores in small numbers only and were found only after prolonged and careful searching. It was noticed in the cultures that these hyphae were most numerous in areas away from the fibre hyphae and fructifications. It is therefore possible that these hyphae may be more abundant in the decayed wood, under the carpophores. In support of this view, it may be added here that large numbers of such hyphae were seen on the surface and in the vessels of a specimen of wood decayed by an unknown fungus which was recently examined by the author. This fungus displayed all the hyphal characters of cultures of species in group 25 (unpublished data).

Cystidia were not reported from the carpophores by Overholts (1953) but Bourdot & Galzin (1928) and Talbot (1954 a) figured fusiform, thick-walled cystidia which they regarded as hyphae projecting into the hymenium from the underlying tissues. Many of these projecting hyphae were seen in some specimens and some of these pseudo-cystidia (Lentz, 1954) or tramal cystidia (Donk, 1964) were rather characteristic in form (Fig. 12 p). They resemble normal fibre haphae in all characters except in their length and appear to be stunted fibre hyphae. Some of these structures were seen to be borne in the same position as the basidia on the same nodose-septate hyphae. These are regarded as skeleto-cystidia and have thick, refractive walls and narrow, aseptate lumina like fibre hyphae but lack their length. They fit the description of skeleto-cystidia given by Donk (1964, p. 234) very well.

The fibre hyphae from the carpophores are slightly darker in colour and generally larger in diameter than those from the cultures but are in other respects closely similar. As described here, they agree well with the descriptions by Cunningham (1948 h), Pinto-Lopes (1952), Overholts (1953) and Teston (1953 b) who stated that the fibre hyphae are more or less straight and unbranched or rarely branched.

From the above descriptions it is evident that the structures formed in culture are also present in the carpophores from which they were made. No chlamydospores were seen in the carpophores but they have been reported in hyphae present in the decayed wood (Cartwright & Findlay, 1946).

Cunningham (1948 h), in his characterization of the genus *Daedalea* Pers. ex Fr. stated that *Daedalea quecina*, the type species, has a trimitic hyphal system with the "binding hyphae aseptate, commonly of the bovista type". Teston (1953 a) and Kotlaba & Pouzar (1957) agreed. Teston (1953 a) reported that the binding hyphae were narrower more tortuous and branched more frequently than the skeletal hyphae. Teston's figures (1953 b, P14: 8) show hyphae which resemble the branches of fibre hyphae as illustrated here in Fig. 12 k. These branches perform a binding function but they are morphologically similar to and continuous with the straight fibre hyphae. These branches contribute to the binding system, as described by Corner (1932 a) in the case of some skeletal hyphae in the fruit-body of *Polystictus xanthopus* but they differ morphologically from the true binding hyphae from the fruit-body of *Polystictus xanthopus* (Corner 1932 a) or those of *Fomes fomentarius* (Teixeira, 1962 a) in their limited branching and unlimited growth. These branches can thus not be regarded as true binding hyphae. Nor were binding hyphae of the bovista type as described by Cunningham (1948 h), found in the tissues of the specimens examined. Donk (1964) furthermore accepted Corner's (1953) view that Cunningham's (1946) "binding hyphae of the bovista type"

are branched skeletals. This agrees with the observations described above. For these reasons the fruit-bodies of *Daedalea quercina* must be regarded as having a dimitic hyphal system in the sense of Corner (1932 a, b), Cunningham (1946) and Teixeira (1962 b). This conclusion contradicts the reports by Cunningham (1948 h) and Teston (1953 b).

Fidalgo (1957) discussed the nomenclatural status of *Daedalea* Pers. ex. Fr. and related genera. He concluded that the only distinction between the genera *Daedalea* Pers. ex Fr., *Lenzites* Fr. and *Trametes* Fr. is in the hymenial configuration, a character which is so variable in species of this group, as to be without significance. *Daedalea* Pers. ex Fr., *Trametes* Fr. and *Lenzites* Fr. are thus synonyms in his view; but comparison between the descriptions of *Daedalea quercina* on the one hand and *Trametes suaveolens* (L. ex Fr.) and *Lenzites betulina* (L. ex Fr.) Fr., the type species of *Trametes* Fr. and *Lenzites* Fr. respectively (Donk, 1960) on the other hand, shows that clear and significant distinctions in hyphal characters and construction exist between these species, viz.: hyphae with many, short, tortuous, thick-walled, aseptate branches, arising from thin-walled, nodose-septate hyphae and binding the tissues together (Fig. 23 d; 26 g) are abundant in the carpophores of *Trametes suaveolens* and *Lenzites betulina* but entirely absent from those of *Daedalea quercina*. The nodose-septate hyphae with irregularly thickened walls which are found in the carpophores, and, more abundantly, in the cultures of *Daedalea quercina* are entirely absent from the carpophores and cultures of *Trametes suaveolens* and *Lenzites betulina*. Furthermore, *Daedalea quercina* causes a brown rot (Overholts, 1953) and its cultures do not produce extra-cellular oxidase while cultures of *Trametes sauveolens* and *Lenzites betulina*, which cause white rots (Overholts, 1953), produce extra-cellular oxidase (see Group 45). These differences in hyphal composition, construction of the carpophores and biochemical activity of these two species indicate important phylogenetic differences which must necessarily outweigh all taxonomic considerations based on superficial similarities such as form, texture and colour of the carpophores. For these reasons the genus *Daedalea* Pers. ex Fr. is not congeric with the genera *Trametes* Fr. and *Lenzites* Fr. but constitutes a distinct and well-marked generic entity. *Daedalea quercina* thus is the type species of the genus *Daedalea* Pers. ex Fr. which is characterized by carpophores having a dimitic hyphal system consisting of nodose-septate generative hyphae with thin walls, nodose-septate hyphae with irregularly thickened walls, and sub-solid to solid, aseptate, skeletal hyphae unbranched or occasionally branched.

These results must influence the taxonomic positions of a large number of species of polypores because the genus *Daedalea* Pers. ex Fr. is one of the oldest genera accepted by Fries (1821). Together with *Daedalea quercina*, Nobles (1958 b) included a number of other species with similar cultural characters in Group 25. Among these were seven species of the genus *Coriolellus* Murrill, including the type *Coriolellus sepium* (Berk.) Murr. Sarkar (1959) in a study of six of these species, showed that the structures formed in their cultures were also present in their carpophores so that these six species formed a homogenous group which she placed in the genus *Coriollelus* Murr. From her descriptions it is evident that the hyphal characters of these species of *Coriolellus* are very similar to those of *Daedalea quercina* as described above. Other carpophore characters such as spore shape, carpophore texture, upper surface and attachment as well as the type of decay and host range also agree in many respects. The main differences are the absence of the daedaloid hymenial surface of *Daedalea quercina* and the presence of nodose-septate hyphae with uniformly thickened walls in its carpophores. Such hyphae were interpreted as "early stages of fibre hyphae" by Sarkar (1959) and were found in all the species of *Coriolellus* Murr. described by her. It thus appears

that the genus *Coriolellus* Murr. has so many characters in common with the type species of the genus *Daedalea* Pers. ex Fr. that these six species described by Sarkar (1959) should be transferred to the genus *Daedalea* Pers. ex Fr. Certain workers, however, consider the absence or presence of certain types of hyphae in fruit-bodies to be of importance at the genus level (Bondartseva, 1961; Teixeira, 1962b; Fidalgo & Fidalgo, 1963, 1966), and these hyphae described as "early stages of fibre hyphae" by Sarkar (1959) are absent from the carpophores of *Daedalea quercina*. Although the hyphal characters of too small a number of species have been studied with sufficient care and accuracy to properly evaluate the significance of a difference of this nature, it appears that the transfer of these six species of *Coriolellus* to the genus *Daedalea* Pers. ex Fr. by Aoshima (1967), is acceptable.

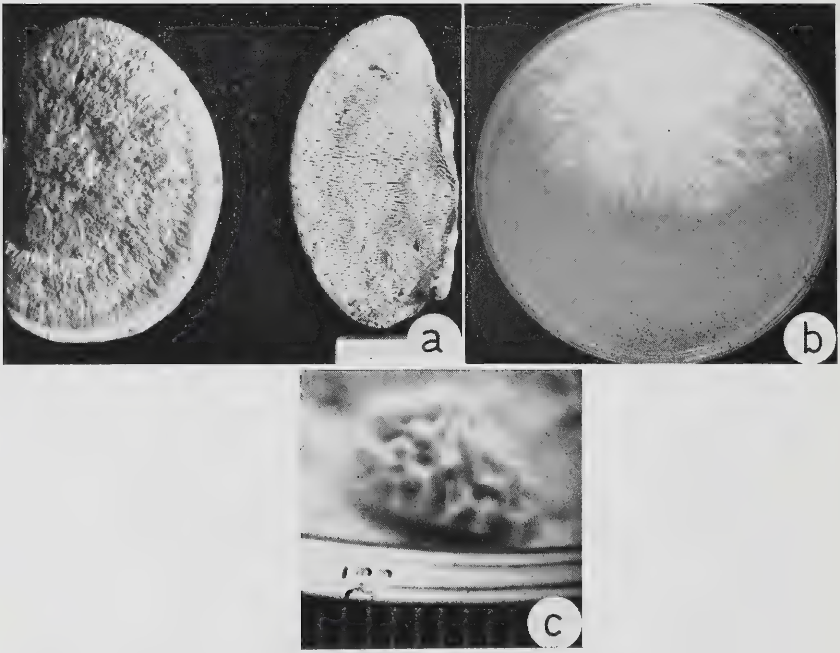

Fig. 13.—**Trametes moesta.** (a) Carpophores of PRE 42241 upper and hymenial surfaces; (b) culture of PRE 42241 at 6 weeks; (c) fructification in culture, × 4.

Trametes moesta *Kalchbrenner*, Fungi Macowaniana, Grevillea 10, 56, 1881.

Cultural characters

Growth is slow the mat reaching a radius of up to 25 mm in two weeks and up to 50 mm in six weeks. The margin is bayed and somewhat ragged with the hyphae raised to the limit of growth, cottony at first, becoming woolly and finely farinaceous, white, with small patches of felty mycelium developing on the surface of the agar, the patches increasing in size but becoming granular towards the inoculum and coalescing to form a dense, felty, mat around the inoculum and against the sides of the dish. Fertile areas appear as small depressions or irregular

ridges on these parts, after 5-6 weeks. At six weeks faint, radiating grooves may be seen in the younger more woolly mycelium with small, elongated tufts of dense mycelium over this part. Mat white, with occasionally "pale ochraceous buff" tinges on the felty patches. The reverse is bleached and a faint, slightly fragrant odour is given off. The oxidase reaction is negative when tested with gum guaiac solution.

Advancing mycelium: hyphae hyaline, nodose-septate, clamp connections simple, branching mostly near the septa, 2.2 — 5.5μ in diameter, the contents staining deeply in phloxine (Fig. 14 a).

Aerial mycelium: (a) thin-walled, nodose-septate hyphae as in the advancing zone; (b) nodose-septate hyphae with irregularly thickened walls and contents staining deeply in phloxine, branching or unbranched 1.5 — 5.0μ in diameter (Fig. 14 b); (c) fibre hyphae hyaline, long, unbranched or branching occasionally, solid or sub-solid with slight beadlike swellings with prominent lumina in those parts and the ends usually thin-walled, 1.5 — 5.2μ near the origin and widening gradually to 4 — 5μ at the widest part; others narrow, 0.7 — 1.0μ in diameter for some distance then widening suddenly to 4 — 5μ with the lumina more prominent and continuous or in a series of ellipsoidal spaces with deeply staining contents (Fig. 14 c).

Fructification: (a) thin-walled, nodose-septate hyphae as above; (b) fibre hyphae as in aerial mycelium but usually narrower, 2.5 — 3.5μ; (c) basidia long clavate 20 — 27 x 5.5 — 7.5μ with 4 straight sterigmata, 3 — 4μ long (Fig. 14 d); (d) basidioles 1.2 — 4μ wide, often with narrow branches, thin-walled, hyaline, arising from the basidial fasicles (Fig. 14 e); (e) basidiospores hyaline, long ellipsoidal to cylindrical and flattened on one side, with a marked apiculum, smooth, thin-walled, 6.0 — 8.5 x 3.0 — 4.2μ (Fig. 14 f).

Submerged mycelium: a thin-walled, nodose-septate hyphae as in the advancing zone; (b) chlamydospores abundant, hyaline, subglobose to ellipsoidal, intercalary or terminal, thick-walled, borne on thin-walled, nodose-septate hyphae 4.5 x 6.0 — 8.0μ (Fig. 14 g).

Carpophore characters

Carpophores perennial, lignicolous, solitary or grouped, sessile, dimidiate; pileus applanate to thick convex, single, laterally connate or imbricate, rigid, hard, corky, up to 12 x 7 x 3 cm; surface at first finely tomentose to sub-glabrous, smooth or somewhat rugulose and slightly rimose in age, at first creamy white, darkening to "pinkish buff" later to "avellaneous" in mature specimens or blackish in oldest parts; margin obtuse, thick, entire, creamy white when fresh, darkening to "pale pinkish buff" or "pinkish buff"; pore surface creamy white when fresh drying to somewhat dirty white or umber in older parts, poroid to daedaloid; pores elongate, angular, 0.5 — 1.0 mm wide; dissepiments dentate, thin; tubes whitish 0.5 — 12 mm deep, becoming stuffed with white hyphae; context "wood brown", zonate, fibrous, 1 — 10 mm thick, darkening with KOH.

Hyphal characters: (i) nodose-septate hyphae hyaline, branching, forming H-connections, thin-walled, contents staining in phloxine, 1.2 — 3.0μ in diameter (Fig. 14 h); (ii) nodose-septate hyphae with irregularly thickened walls, lumina irregularly narrowed and deeply staining contents, branching and forming H-connections, 2.4 — 4.5μ in diameter, rare (Fig. 14 k); (iii) fibre hyphae long, sub-hyaline to pale brownish, straight or flexuous, unbranched or with one to three branches, narrow near the origin but widening towards the middle, walls thickened, refractive, lumina narrow or obliterated often visible as interrupted lines, prominent towards the

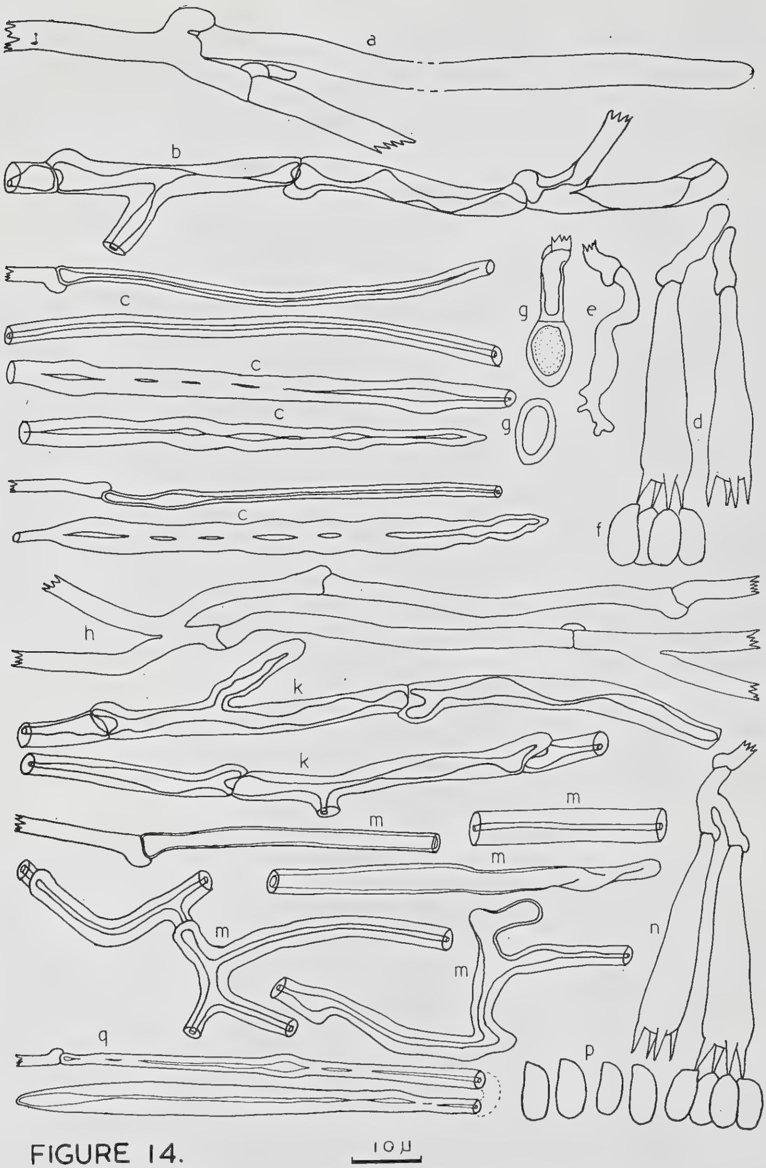

FIGURE 14.

FIG. 14.— **Trametes moesta.** a - g. Structures from cultures: (a) thin-walled, nodose-septate hyphae from advancing zone; (b) nodose-septate hyphae with irregularly thickened walls; (c) fibre hyphae; (d) basidia; (e) basidioles; (f) basidiospores; (g) chlamydospores.

h - q. Structures from carpophores: (h) thin-walled, nodose-septate hyphae; (k) nodose-septate hyphae with irreguarly thickened walls; (m) fibre hyphae; (n) basidia; (p) basidiospores; (q) tramal cystidium.

extremities, aseptate or with occasional simple septa near the tips, 2.5 — 6.0μ in diameter (Fig. 14 m).

Hymenium: basidia long clavate, 22.0 — 30.0μ long, bearing four, straight, slender sterigmata 2.5 — 3.0μ (Fig. 14 n); basidiospores hyaline, cylindrical, thin-walled, smooth 7.2 — 9.8 x 3.3 — 4.2μ (Fig. 14 p); tramal cystidia sub-hyaline, tapering towards the tips, thick-walled, with narrow lumina, 3.0 — 6.0μ in diameter projecting up to 40μ beyond sub-hymenium, arising from trama as widened terminal portion, 50 — 80μ long, of short, narrow, fibre hyphae 1.5 — 3.0μ in diameter (Fig. 14 q).

Construction. At the margin the tissues consist of long, unbranched, hyaline fibre hyphae usually with prominent lumina and thin-walled extremities, often collapsed 3.0 — 4.0μ in diameter. These fibre hyphae are arranged more or less parallel to the direction of growth of the carpophore and loosely intertwined with each other and the numerous narrow, branching, thin-walled, nodose-septate hyphae from which they arise. In the older parts of the context the construction is similar but the fibre hyphae are darker in colour, their walls are thicker, the lumina are often reduced to narrow interrupted lines and the hyphae are of greater diameter, up to 6.0μ. Few nodose-septate hyphae are present. In the upper context the fibre hyphae are mostly sub-solid, more or less parallel to and intertwined with each other and with their ends closely packed at a common level to form the finely pubescent upper surface. Near the upper surface thin-walled, nodose-septate hyphae are fairly numerous, intertwined with the fibre hyphae and branching freely between them and across their direction of growth. In the older tissues thin-walled, nodose-septate hyphae are rather rare. In the lower context some fibre hyphae turn downwards to form the trama of the dissepiments. The fibre hyphae are somewhat narrower, 2.4 — 4.5μ, with wider lumina than in the upper context and more flexuous, often with a somewhat beaded appearance and many with one to three long branches, of similar appearance. These hyphae and their branches are tightly intertwined with each other as well as thin-walled, branching, nodose-septate hyphae and occasional nodose-septate hyphae with irregularly thickened walls to form the dense tissues of the lower context and trama. The nodose-septate, thin-walled hyphae become very numerous by repeated branching towards the hymenial surfaces where abundant, short, narrow branches produce the basidia. From the tramal tissues short fibre hyphae with narrow lower portions which suddenly increase in diameter towards the upper part (Fig. 14 q) and 50 — 90μ in length, project into the hymenium as tramal cystidia. Some branches of fibre hyphae may also project into the hymenium.

Decay and hosts

This species causes a brown rot of stumps of hardwood trees.

Specimens examined

Herb. PRE: 11288, coll. A. Roberts, May 1915; 34391, on indigenous hardwood, Hluhluwe Game Res., Oct. 1935; *42241, on *Acacia mearnsii* stump, Kaapse Hoop, Tvl., Feb. 1961; *42242, on *Acacia mearnsii* stump, Kaapse Hoop, Tvl., Feb. 1961; *42442, on *Acacia mearnsii* stump, Kaapse Hoop, Tvl., Feb. 1961.
Herb. STE: 538, as *Daedalea moesta* Kalchbrenner.

Interfertility studies

In order to test the possibility of conspecificity between this species and *Daedalea quercina,* which is very similar to *Trametes moesta,* four cultures made from single spores obtained from a fructification formed in culture by *Trametes moesta* PRE 42241, were paired on agar slopes in all possible combinations with

four cultures made from single spores of *Daedalea quercina* DAOM 2278. Four days after the mycelia had met on the slopes, the cultures were examined for the presence of clamp connections.

No clamp connections were found in any of the cultures thus indicating that *Daedalea quercina* and *Trametes moesta* are two different species.

Discussion

This species was described by Kalchbrenner (loc. cit.) from a collection by Tyson which could not be located for examination The specific epithet of the specimens examined in this study is based on Van der Bijl's description (1922 a), the collection PRE 11288 cited by him, and collection No. 538, *Daedalea moesta* Kalch. in the P. A. van der Bijl Herbarium, University of Stellenbosch. The other specimens cited above agree very well with Van der Bijl's description and specimens.

This species is not well-known in South Africa and the collections cited above are the only records of its occurrence. The three collections from Kaapse Hoop, are probably part of the same population of this fungus in that region since they were made from different hosts in a fairly small area. It is probable that the species may be much more widely distributed than these records would indicate.

The cultural characters of *Trametes moesta* had not been described before In culture the fungus forms nodose-septate hyphae, some with irregularly thickened walls, and fibre hyphae, whilst no extra-cellular oxidase is produced. This species thus displays all the characteristics of species included in Group 25 by Nobles (1958 b).

In cultural characters *Trametes moesta* resembles *Daedalea quercina* very strongly but differs from it in a slower growth rate, even margin, generally smoother topography of the mat and the formation of granular, fertile areas from which ridges more delicate than those in cultures of *Daedalea quercina,* arise. Cultures of *Trametes moesta* differ from those of species of the genus *Coriolellus* Murr., as described by Sarkar (1959) in the absence of the refractive projections from their nodose-septate hyphae with irregularly thickened walls. In most respects their cultures appear to be strikingly similar however, but the differences mentioned here may serve to distinguish cultures of *Trametes moesta* from those of other species if considered together with host and locality records if available.

Van der Bijl (1922 a) described the hyphae in carpophores of *Trametes moesta* as "simple, 2 — 4μ in diameter". This agrees to some extent with the description given above as the bulk of the hyphae in the carpophore are thick-walled, aseptate, fibre hyphae mostly unbranched or occasionally branched. Nodose-septate, thin-walled hyphae are abundant in the growing margin, tramal tissues and, to a lesser extent, near the upper surface of the carpophore. Nodose-septate hyphae with irregularly thickened walls were found in small numbers in the lower context and tramal tissues. Since hyphae with clamp connections at their septa must be regarded as generative hyphae, according to Corner (1953), Teixeira (1962 b), and Donk (1964), only two kinds of hyphae, generative and skeletal hyphae are present in the carpophores of *Trametes moesta.* This species thus has a dimitic hyphal system (Corner, 1932 a, b; Cunningham, 1946, 1954).

The structures that were found in the cultures of *Trametes moesta* were also present in the carpophores. The fibre hyphae were somewhat larger in diameter in the carpophores than in the cultures and were pale brownish rather than hyaline or sub-hyaline as in the cultures. The thin-walled, nodose-septate hyphae were abundant in the margin and dissepiments of the carpophores but the nodose-septate hyphae with irregularly thickened walls, were seen only rarely and occurred

mostly in mounts made from the older parts of the lower context just above the dissepiments.

The peculiarly branched structures seen in the hymenia of some fructifications formed in culture, were not seen in the carpophores. It was noticed at the time that the cultures in which these occurred, showed signs of dessication. Since these structures were formed on the basidial hyphae in the hymenium, they were regarded as deformed basidia formed under dry conditions as described by Bose (1943) in carpophores of *Polyporus sanguineus* and *Ganoderma lucidum*.

The carpophores of *Trametes moesta* are strikingly similar to those of *Daedalea quercina* in hyphal composition, construction and morphology. The types of hyphae found in *Daedalea quercina* were also found in carpophores of *Trametes moesta*. In both species the fibre hyphae, which make up the bulk of the carpophores are arranged in parallel and slightly intertwined and unbranched in the upper context. They are more frequently branched and tightly interwoven in the lower context and dissepiments. In both species short fibre hyphae or branches of fibre hyphae project as tramal cystidia from the tramal tissues of the carpophores. Both species cause brown rots in hardwood stumps or logs, but the non-appearance of clamp connections when single spore mycelia of these two species were mated, indicate that they are not conspecific.

Although carpophores of these two species are so strikingly similar in morphology and anatomy, small but consistent differences are present, viz.: the upper surface of carpophores of *Trametes moesta* have pale reddish-brown colours not common in *Daedalea quercina;* the pore surface of *Trametes moesta* is mostly poroid with the angular pores much smaller and dissepiments more delicate than those of *Daedalea quercina*. The basidiospores of *Trametes moesta* are longer and more markedly cylindrical than those of *Daedalea quercina*. Differences of this nature do not outweigh the great similarity in cultural characters and carpophore anatomy and are regarded by most workers as of interspecific value only. Therefore, these two species must be congeneric and *Trametes moesta* Kalch. should be transferred to the genus *Daedalea* Pers. ex Fr. as typified by *Daedalea quercina* L. ex Fr.

Trametes roseola Patouillard & Hariot, in Journal de Botanique 14, 239, 1900.

Cultural characters

Growth is slow, the mat reaching a radius of 27 mm in two weeks and covering the plate in 5 weeks. The margin is even, with mycelium appressed for about 1 mm, then raised, white, cottony behind the margin but becoming woolly towards the inoculum. After 3 weeks small, rounded, lumps of dense mycelium form along a narrow zone and on the sides of the plate, later covering the younger part of the mat in distinct zones of pebbly mycelium alternating with zones of smooth, felty mycelium. After six weeks the plates are covered, the mats raised, woolly, with a deep, wide, concentric groove in the newest growth and with successive narrow, concentric coarsely farinaceous to pebbly zones, often with "light ochraceous buff" colours and traversed by shallow radial grooves. About halfway across the mat and towards the inoculum, the texture is cottony-woolly. Mat is white at first, but turns a very pale "seafoam yellow" colour. Lumps of compact mycelium "light ochraceous buff" or "cinnamon buff" or "dresden brown" in colour appear on the surface after 3 — 4 weeks and later may develop minute pores over the surface. The reverse is unchanged at first but bleaching after 4 — 5 weeks. A faint, fragrant odour is given off. The oxidase reaction is negative when tested with gum guaiac solution.

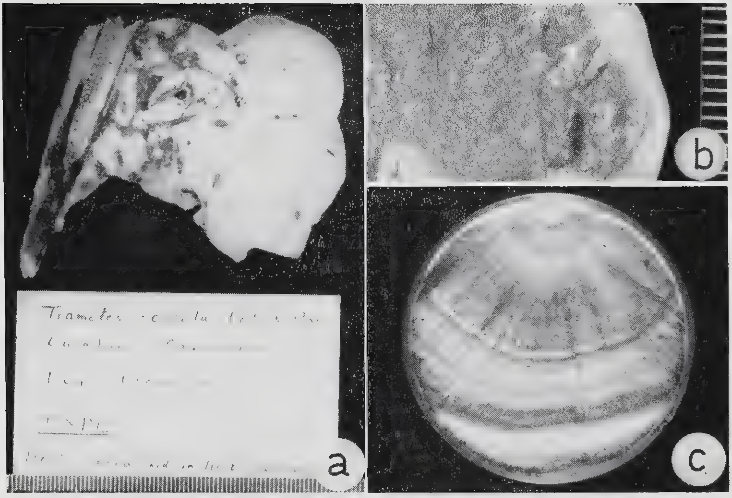

FIG. 15.—**Trametes roseola.** (a) Carpophore of type specimen, upper surface and (b) hymenial surface; (c) culture of PRE 42443 at 6 weeks.

Advancing mycelium: hyphae hyaline, simple or branching near the septa, nodose-septate with deeply staining contents 2.2 — 4.5μ in diameter (Fig. 16 a).

Aerial mycelium: (a) hyphae as in the advancing zone; (b) nodose-septate hyphae with irregularly thickened walls, often solid and refractive in parts, branched or unbranched 2.5 — 4.5μ in diameter (Fig. 16 b); (c) fibre hyphae hyaline at first, later subhyaline, unbranched or very occasionally branched, walls thick and refractive, lumina narrow, widening near the tips, aseptate or occasionally with one or two simple septa, 2.5 — 3.5μ, arising from thin-walled, nodose-septate hyphae and of fairly slow growth (Fig. 16 c).

Submerged mycelium: (a) hyphae as in the advancing zone; (b) nodose-septate hyphae with irregularly thickened walls as in aerial mycelium; (c) chlamydospores terminal or intercalary, ovoid or ellipsoid with thick, refractive walls 18.0 — 30.0 x 9.0 — 12.0μ (Fig. 16 d).

Carpophore characters

Carpophore annual or perennial, lignicolous, solitary, sessile, pileus conchate to somewhat spathulate, soft corky, drying to corky, up to 5.5 x 6.0 x 1.2 cm; surface finely pubescent, smooth, mat, azonate, "pale ochraceous buff" to "light pinkish cinnamon" or becoming fuscous in parts in older specimens; margin obtuse, entire, thick and rounded, concolorous with upper surface; pore surface "seashell pink" darkening to "vinaceous cinnamon" or "buff brown" and cracking on drying; pores rounded or slightly angular, 5 — 8 mm, dissepiments even; tubes pale yellowish, 0.5 — 1.0 mm deep, stratified in some specimens, decurrent at point of attachment; context pale "ochraceous buff" to "light pinkish cinnamon" floccose or somewhat fibrous, with occasional concentric, darker zones, and darkening in KOH.

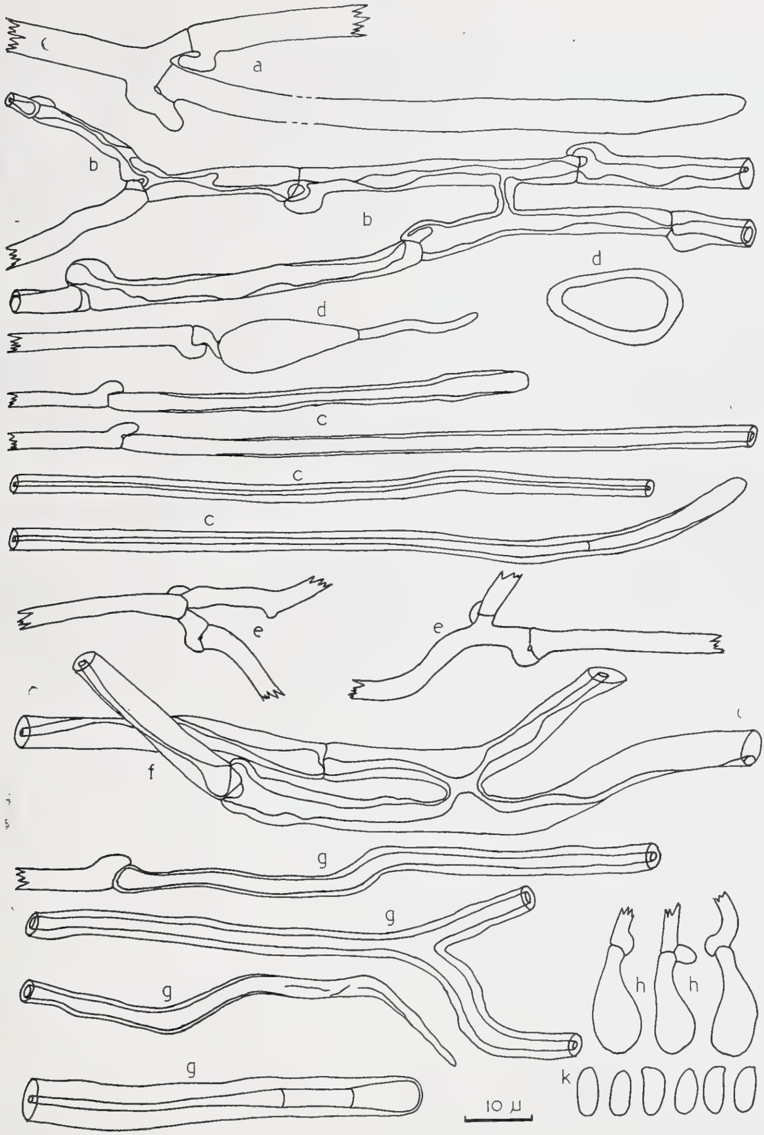

FIGURE 16.

FIG. 16.—**Trametes roseola.** a - d. Structures from cultures: (a) thin-walled nodose-septate hyphae from advancing zone; (b) nodose-septate hyphae with irregularly thickened walls; (c) fibre hyphae; (d) chlamydospore.
e - k. Structures from carpophores: (e) thin-walled, nodose-septate hyphae; (f) nodose-septate hyphae with irregularly thickened walls; (g) fibre hyphae; (h) basidia; (k) basidiospores.

Hyphal characters: (i) nodose-septate hyphae hyaline, thin-walled, with deeply staining contents and branching near the septa 2.0 — 3.0μ in diameter (Fig. 16 e); (ii) nodose-septate hyphae with walls irregularly thickened and refractive, hyaline, branching near the septa, forming H-connections, 3.0 — 6.0μ in diameter (Fig. 16 f); (iii) fibre hyphae sub-hyaline to pale brownish, straight or flexuous, mostly unbranched, occasionally branched, thick-walled the lumina prominent or narrow, seldom occluded, aseptate or occasionally with one or two simple septa near the thin-walled tips, narrow and thin-walled towards the origin, arising from thin-walled, nodose-septate hyphae, 2.2 — 7.0μ in diameter (Fig. 16 g).

Hymenium: basidia hyaline, clavate 8.0 — 15.0 x 4.5 — 6.0μ with short, straight sterigmata 1.5 — 2.2μ (Fig. 16 h); basidiospores hyaline, long ellipsoidal to cylindrical, smooth, thin-walled 4.8 — 6.0 x 2.2 — 2.8μ (Fig. 16 k).

Construction. The margin consists of long, straight, unbranched fibre hyphae, walls subhyaline to pale brownish, arranged more or less parallel to or somewhat intertwined with each other, their tips projected forward to form the margin of the pileus. Branching, narrow, hyaline, thin-walled, nodose-septate hyphae, from which the fibre hyphae arise, are intertwined and interwoven with them just behind the margin. Towards the upper context the fibre hyphae are darker in colour, with thicker walls and are of larger diameter than in the margin but also parallel to each other and turning upwards towards the upper surface where their thin-walled ends are closely packed at a common level to form the finely pubescent to subglabrous upper surface. Just below the upper surface, narrow, thin-walled, branching, nodose-septate hyphae, intertwined with the fibre hyphae, are fairly numerous. In the older tissues few nodose-septate hyphae are present. The lower context consists of long fibre hyphae, straight or flexuous, 3.0 — 4.0μ in diameter, occasionally branched, walls thickened, but lumina prominent, more or less parallel to one another and slightly intertwined with one another and with small numbers of thin-walled, branching, nodose-septate hyphae from which they arise and occasional nodose-septate hyphae with irregularly thickened walls, 3.0 — 6.0μ in diameter. From the lower context the hyphae turn downwards into the dissepiments where the fibre hyphae are narrower and become very flexuous and more tightly interwoven than higher up in the context. Thin-walled, nodose-septate hyphae with deeply staining walls are numerous, branching frequently and anastomosing parallel to and across the direction of growth of the fibre hyphae and turning outwards toward the pore surfaces with increased branching to form the tightly interwoven, short, nodose-septate branches of the sub-hymenium bearing the basidia. Also in the dissepiments are occasionally portions of nodose-septate hyphae with irregularly thickened walls, continuous with the thin-walled, nodose-septate hyphae.

Decay and hosts

Trametes roseola causes a brown rot of broad-leaved trees. Hopkins (1939, 1943) reported this species as the cause of stem rot of living trees in Rhodesia.

Specimens examined

Herb. PRE: 26709, on *Eucalyptus ficifolia,* Pietermartizburg, 1934; 28560, on *Acacia mearnsii,* Impolweni Natal, Sept. 1934; 30191, on *Acacia mearnsii,* Melmoth, March, 1935; 30634, on living *Prunus persica,* Rhodesia, June 1937; 30204, on *Acacia mearnsii* wood, Melmoth, Natal 1935; 24116, on dead wood, Albert Falls, Natal; 39016, on dead wood, ex Herb. Timber Res. Lab., Johannesburg; *42443, on decayed hardwood log, Bushbuckridge, Tvl., Feb. 1961. *Herb.* Patouillard in FH: Sheet no. 2853, 3 collections in packets marked: "Caraban (Casamance) Leg. Chevalier"; "313, sur branche mort, Reserve forestiér de Compong Chnang, Cambodge, Juillet 1921, M. Perclot;" "Madagascar, M. Decary 1920."

The specimen from Caraban on Patouillard's sheet no. 2835, agrees with the collection data mentioned in the original description (Patouillard & Hariot, 1900) and must therefore be designated the type specimen (Fig. 15 a, b).

Discussion

The presence of aseptate fibre hyphae and nodose-septate hyphae, some with irregularly thickened walls, and the absence of extra-cellular oxidase enzymes in its cultures, place *Trametes roseola* in Group 25 (Nobles, 1958 b). Its cultural characters agree well with those of other species in this group but the pale yellowish-green colour of the mycelial mat, the colour of the poroid, felty lumps in the cultures and the slow-growing fibre hyphae are unique in cultures of *Trametes roseola* and serve to distinguish this species from others in Group 25. This species had not been described in culture before.

The South African collections of this fungus agree very well in morphological and hyphal characters with Patouillard's collections, one of which is designated as the type. All the carpophores were rather small, with minute pores barely visible to the naked eye, fairly thick dissepiments and with a soft, "trametoid" feel and appearance. To the type specimen is attached a small piece of hardwood, from which it grew, showing a characteristic brown rot. No spores could be found on the type specimens but young basidia were very numerous. There is no doubt that the South African specimens are conspecific with Patouillard's collections.

From the description it is evident that the carpophores of *Trametes roseola* are simple in construction. They consist of three types of hyphae only, viz. thin-walled, nodose-septate hyphae, nodose-septate hyphae with irregularly thickened walls and fibre hyphae. The fibre hyphae are mostly unbranched and lightly intertwined. The nodose-septate hyphae are branched but not tightly interwoven with the fibre hyphae. There is an almost total absence of a binding function in the hyphal elements so that the fruit-bodies feel soft and somewhat fragile.

From the descriptions, it is evident that the vegetative structures formed in culture are also present in the carpophores. As in other species of this group, the nodose-septate hyphae with irregularly thickened walls were very numerous and prominent in the cultures but rare in the carpophores. In one carpophore, PRE 42443, however, these hyphae were fairly abundant in a narrow zone between two layers of tubes and towards the middle of the carpophore where they were visible as a faintly greenish patch in the otherwise apricot-coloured context tissue.

In gross morphological features and texture of its carpophores, *Trametes roseola* resembles *Trametes suaveolens* (L. ex Fr.) Fr., the type of *Trametes* Fr., very closely. Comparison of their hyphal characters, however, reveals that this resemblance is entirely superficial since the short, much branched fibre hyphae (or binding hyphae), present in carpophores of *Trametes suaveolens*, are absent from the carpophores of *Trametes roseola*. Nodose-septate hyphae with irregularly thickened walls are present in carpophores and cultures of *Trametes roseola* but not in those of *Trametes suaveolens*.

The similarities in cultural characters and hyphal characters of their carpophores indicate close affinities between *Trametes roseola*, *Daedalea quercina* and species of the genus *Coriolellus* Murr. described by Sarkar (1959). The small fruit-bodies of these *Coriolellus* species however, contain hyphae described by Sarkar as "immature fibre hyphae" or "incompletely differentiated fibre hyphae." These hyphae, from her figures, are thick-walled, nodose-septate or "sclerified generative hyphae" (Donk, 1964) which are also formed in cultures of these fungi. Such hyphae are absent from cultures and carpophores of both *Trametes roseola* and *Daedalea quercina*. Because it is not known at present whether the formation of thick-walled, nodose-septate hyphae, in species of which the carpophores consist mainly of aseptate fibre hyphae, takes place as a result of the influence of

environmetal factors or genetic factors, it appears to be advisable not to group *Trametes roseola* with these species of *Coriolellus* Murr. Donk (1966) recently transferred these *Coriolellus* spp. described by Sarkar (1959), to the genus *Antrodia* Karsten. The type species of *Antrodia* Karst., *Trametes mollis* (Sommerf.) Fr., however, lacks nodose-septate hyphae with irregularly thickened walls in its cultures. Nobles (1958 b) placed cultures of this species in her Group 48 which differ from cultures of Group 25 by the presence of a brown mycelial mat and the production of extra-cellular oxidase enzymes.

Although the cultural characters and hyphal characters of the fruit-bodies of *Trametes roseola* resemble those of *Daedalea quercina* in so many respects, their fruit-bodies do not appear to be so markedly similar in gross morphology. Fruit-bodies of *Trametes roseola* are smaller, of different colour and softer in texture than those of *Daedalea quercina* and have small pores rather than daedaloid dissepiments. They also lack tramal or skeleto-cystidia. On the other hand, the fruit-bodies of *Trametes roseola* are constructed in the same way and of the same types of hyphae as those of *Daedalea quercina* and further have the same thick dissepiments, anoderm surface, cylindrical spores and context darkening in KOH. Furthermore, fruit-bodies of *Trametes roseola* with a daedaloid hymenial surface were figured and reported by Lloyd (1922, p. 1145) from North Borneo. The differences in gross morphology of the carpophores of these two species thus appear to be of minor importance. Many workers (e.g. Teixeira, 1962 b; Furtado, 1965 a, b) regard hyphal characters as important at the generic level. As the carpophores of these two species agree in so many hyphal and micromorphological characters, the differences between them appear to be of interspecific nature only and *Trametes roseola* appears to be congeneric with *Daedalea quercina*, the type species of the genus *Daedalea* Fr.

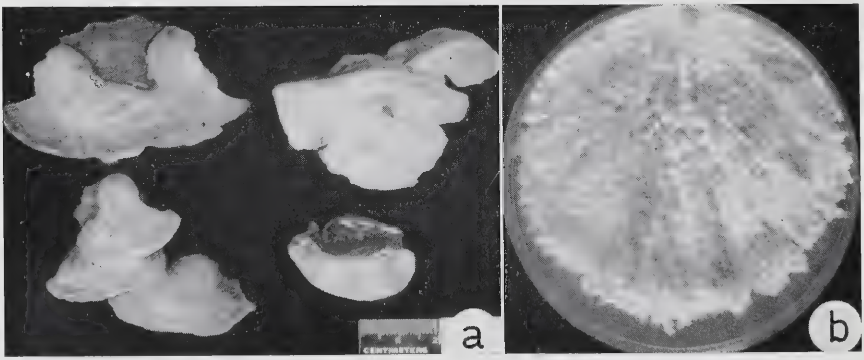

Fig. 17. — **Fomes cajanderi.** (a) Carpophores of DAOM 31973; (b) culture of DAOM 31973 at 6 weeks.

Fomes cajanderi *Karsten*, Finska Vet.-Soc. Ofv. Forh. 46 (11), 8, 1904.

Trametes subrosea Weir, Rhodora 25, 217, 1923;

Fomitopsis subrosea (Weir) Bond. & Sing., Ann. Mycol. 39, 55, 1941;

Fomitopsis cajanderi (Karst.) Kotlaba & Pouzar, Ceská mykologie 9, 157, 1957.

Cultural characters

Growth moderately fast to slow the colony reaching a radius of about 40 mm in two weeks covering the plates in 4 to 5 weeks. Margin even to slightly bayed with mycelium raised to limit of growth. Behind the margin mat is thin, cottony, raised but collapsing to sub-felty, or, more compact to almost velutinate around the inoculum, white at first but soon developing "seashell pink" to "pale salmon color" tints near the inoculum. Later the areas of more compact mycelium develop irregular, pellicular-felty patches which gradually enlarge and coalesce to form smooth or vaguely, radially, grooved patches of raised, felty mycelium on which angular pores, labyrinthiform at first, develop. These patches gradually become seashell pink", "pale congo pink" or "hydrangea pink", expanding continually, with the older, coloured areas darkening gradually to "vinaceous pink" or "vinaceous fawn", and "Roods brown" in the oldest tubes. Fruiting areas enlarge gradually by the formation of new tubes around the periphery. The reverse remains unchanged and a faint, sweet odour is emitted. No diffusion zones are formed on gallic acid and tannic acid agar but colonies op to 3.0 cm on the former medium and up to 1.5 cm on the latter, are formed. A negative reaction is obtained when gum guaiac solution is applied to the culture.

Advancing mycelium: hyphae hyaline, nodose-septate, branching at or near the septa, with contents staining deeply, 1.5 — 3.5μ in diameter (Fig. 18 a).

Aerial mycelium: (a) thin-walled hyphae as in the advancing zone, 1.2 — 3.0 — (3.5) μ; (b) nodose-septate hyphae with walls irregularly thickened and refractive and occasionally with refractive projections, lumina irregularly narrowed and staining deeply 1.5 — 4.5μ in diameter, branching freely, numerous in the pellicular areas (Fig. 18 b); (c) fibre hyphae long, straight, unbranched, sub-hyaline or hyaline, solid with lumina visible at the narrower thin-walled ends or sub-solid with very narrow lumina, aseptate, up to 3.0μ in diameter along middle portion (Fig. 18 c); (d) solid, refractive, branching hyphae with hyaline walls and prominent, solid clamp connections, the lumina lacking or reduced to an interrupted line 1.5 — 3.0μ in diameter arising from thin-walled, nodose-septate hyphae or nodose-septate hyphae with irregularly thickened walls (Fig. 18 d).

Fructifications: (a) basidia clavate 10.5 — 18.0 x 4.2 — 5.1μ with four slender sterigmata 2.4 — 3.1μ (Fig. 18 e); (b) basidiospores long-cylindrical or allantoid, obliquely apiculate, hyaline, smooth, thin-walled 4.8 — 6.0 x 1.6 — 2.1μ (Fig. 18 f); (c) fibre hyphae as in the aerial mycelium; (d) nodose-septate hyphae with irregularly thickened walls as in aerial mycelium rare.

Submerged mycelium: (a) thin-walled, nodose-septate hyphae as in the advancing zone 1.5 — 3.0μ in diameter; (b) nodose-septate hyphae with irregularly thickened walls as in the aerial mycelium 1.5 — 6.0μ; (c) chlamydospores rare, intercalary or terminal, ovoid to ellipsoidal, walls slightly thickened, 8.0 — 20.0 x 6.0 — 8.0μ

Carpophore characters

Carpophore annual or reviving a second season, lignicolous, solitary or compound, sessile or effused-reflexed; pileus conchate to applanate, imbricate, often laterally connate, coriaceous to corky, drying rigid, up to 5.0 — 10.5 x 1.7 cm; upper surface at first velvety tomentose but later radially fibrillose or nearly glabrous, smooth or somewhat rugose often zonate, pinkish red at first but soon pinkish brown in age and occasionally with a thin, dark, brittle crust; margin acute, thin, entire, concolourous with upper surface; pore surface "vinaceous" to "orange vinaceous", poroid; pores rounded or angular 3 — 5 mm, dissepiments even; tubes whitish, up to 3 mm deep, stratified; context soft corky, "hydrangea pink" to "congo pink", indistinctly zonate, up to 12 mm thick.

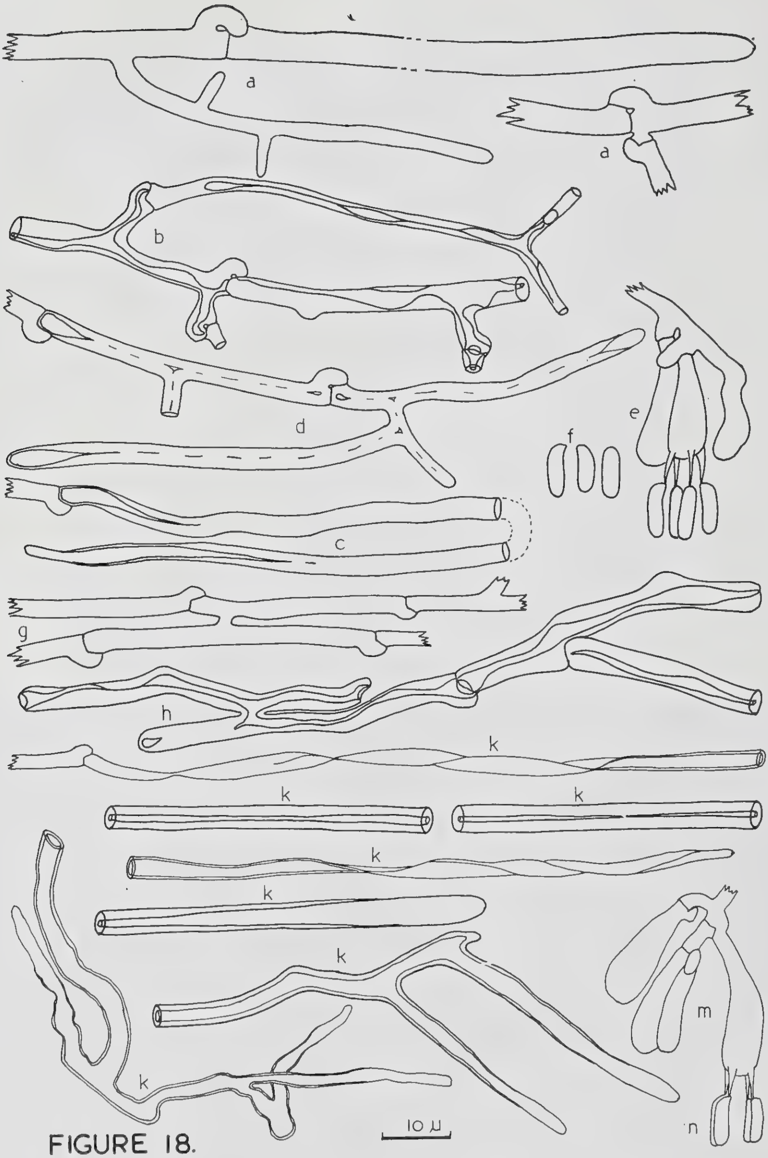

FIG. 18.— **Fomes cajanderi.** a - f. Structures from cultures: (a) hyphae from advancing zone: (b) nodose-septate hyphae with irregularly thickened walls; (c) fibre hyphae; (d) thick-walled or subsolid, nodose-septate hyphae; (e) basidia; (f) basidiospores.

g - n. Structures from carpophores: (g) thin-walled, nodose-septate hyphae; (h) nodose-septate hyphae with irregularly thickened walls; (k) fibre hyphae; (m) basidia; (n) basidiospores.

Hyphal characters: (i) nodose-septate hyphae thin-walled, hyaline, branching at or near the septa, with deeply staining contents, 1.5 — 3.0μ in diameter (Fig. 18 g); (ii) nodose-septate hyphae with irregularly thickened walls hyaline, branched or unbranched, rare, 2.4 — 4.5μ in diameter (Fig. 18 h); (iii) fibre hyphae long, unbranched, or with one or two branches towards the tip, straight or tortuous, thick-walled, sub-hyaline to pale brownish, lumina narrow, aseptate, occasionally occluded, always prominent towards the ends which are thin-walled and often collapsed, 1.5 — 5.0μ in diameter (Fig. 18 k).

Hymenium: basidia narrowly clavate, 12.0 — 15.0 x 4.0 — 5.5μ bearing four short sterigmata 2.1 — 2.4μ (Fig. 18 m); basidiospores long narrow-cylindrical to somewhat allantoid, apiculate, hyaline, smooth, thin-walled, 5.0 — 7.0 x 1.8 — 2.4μ (Fig. 18 n).

Construction. At the margin the carpophore consists mainly of long, straight, unbranched, sub-hyaline fibre hyphae with prominent lumina and thin-walled ends sometimes collapsed, arranged parallel to or slightly intertwined with each other and with numerous, narrow, branching, thin-walled, nodose-septate hyphae from which they arise. Behind the margin and in upper context the fibre hyphae have thicker and darker walls and turn upward towards the upper surface but are still more or less parallel to and slightly intertwined with one another and thin-walled, branching, nodose-septate hyphae, mostly empty and collapsed. Occasional lengths of nodose-septate hyphae with irregularly thickened walls are also present, intertwined with the others. At the upper surface the ends of the fibre hyphae may be arranged parallel to each other and packed at a common level to form a finely pubescent surface or, frequently the ends may be tangled and intermingled with numerous, tortuous, thin-walled, nodose-septate hyphae and agglutinated with a thin layer of lacquer-like substance into a glabrous trichoderm with resinous crust (Lohwag, 1940). Subsequent growth of the hyphae may result in a succession of similar layers which may be up to 500μ thick. In the lower context the fibre hyphae are similar to those in the upper context but turn downwards into the trama of the dissepiments. Towards the tramal tissues the fibre hyphae become generally more tortuous, one or two branches are often formed, the branches being long and similar to the parent hyphae. All hyphae become more tortuous and tightly interwoven and bound into a dense tissue. Below the context towards the trama, thin-walled nodose-septate hyphae with deeply staining contents and branching frequently and repeatedly, become increasingly numerous and tightly intertwined with the fibre hyphae. Nodose-septate hyphae with irregularly thickened walls, some apparently solid, are also fairly numerous in this region and intertwined with the other hyphae. The thin-walled, nodose-septate hyphae branch repeatedly towards the surface of the dissepiments where the basidia are borne in clusters on their numerous branches, 1.8 — 2.4μ in diameter. No accessory structures are present.

Decay and hosts

Fomes cajanderi causes a brown rot of coniferous wood.

Specimens examined

Herb. DAOM: *10278, on *Picea mariana,* Champlain Co., Que.; 17029, on coniferous stump, St. Aubert, Que.; 17164, on *Pseudotsuga taxifolia,* Saanichton, B.C., No. 1959; *17522, on *Picea mariana* slash, Lake Sasiginigate, Man., Aug. 1947; 17528, on *Picea glauca* log, Wasagaming, Man., Sept. 1947; *17529, on *Picea glauca* log, Wasagaming, Man., Sept. 1947; 17572, on *Picea sp.,* Rocky Mt. House, Alta., Oct; 22380, on *Picea sp.,* Harricanaw Riv., Que., June 1946; 22729, on *Abies balsemea,* Tweedie Brook, N.B., July 1949; 30061, on *Picea glauca,* Riding Mt. Nat. Park, Man., July 1950; 31849, on *Pseudotsuga taxifolia,* Cathedral Grove, B.C., May 1948; *31973, on *Tsuga canadensis,* Warrensburg, N.Y., Oct.

1955; 53725, on *Picea* sp., Victoria Park, N.S.; *72322, on *Pseudotsuga taxifolia,* Beacon Hill, Vict., B.C.; *72652, on *Picea mariana,* Warrensburg, N.Y., Sept. 1961; 72742, on *Picea glauca,* Laird River, N.T.; *73183, on coniferous log, S. Santion Highway, Oregon, Aug. 1962.

Discussion

Cultural characters of this species as described here, agree well with the descriptions by Campbell (1938), Davidson *et al.* (1938), Cartwright & Findlay (1946) and Nobles (1948, 1958 b). It fits well into Group 25 and its cultures differ from those of other species in this group mainly in the presence of pinkish colours.

The hyphae of the carpophores of this species have been described by Overholts (1953) who stated: "hyphae pale brown in KOH, long and flexuous, simple, with no cross walls or clamps 2.5 — 5.0μ in diameter". Lowe (1957) later stated that these hyphae were "mixed with a small amount of thin-walled, clamped hyphae, 3 — 5μ in diameter". Farinha (1946) reported clamped hyphae with walls very slightly thickened up to 6μ in diameter in addition to thick-walled, aseptate occasionally branching hyphae from carpophores of this species. None of these authors mentioned the presence of nodose-septate hyphae with irregularly thickened walls in the carpophores as described here and first reported from cultures by Nobles (1948).

From the above descriptions it is evident that the structures formed in the cultures are also present in the carpophores with the exception of the chlamydospores. These may probably be found in decayed wood associated with the carpophores as in the case of *Daedalea quercina* (Cartwright & Findlay, 1946). As in the other three species described here in Group 25, the nodose-septate hyphae with irregularly thickened walls were not very abundant in carpophores of this species either but were nevertheless present in sufficient numbers in the older tissues above the pores to ensure their rapid detection. Basidia and spores are virtually identical in both cultures and carpophores.

The hyphal characters and construction of the carpophores of *Fomes cajanderi* Karst. resemble those of *Daedalea quercina* L. ex Fr. as described above, quite closely. This resemblance indicates a close phylogenetic relationship between these species although morphological differences between them are evident. *Fomes cajanderi* has a poroid hymenium, rose-coloured context and a type of upper surface not found in *Daedalea quercina.* In these characters, *Fomes cajanderi* and *Daedalea quercina* appear to be of interspecific importance only and are outweighed by the similarity in hyphal characters and construction with the carpophores of *Daedalea quercina.*

Fomes cajanderi has been described as *Trametes subrosea* by Weir (1923) but comparison of its hyphal characters with those of *Trametes suaveolens* (L. ex Fr.) the type of *Trametes* Fr. (Donk, 1960) reveals important differences. Carpophores of *Trametes suaveolens* have much branched, fibre hyphae with short tortuous branches, (binding hyphae, Corner, 1932 a; Cunningham, 1946, 1954) in addition to the thin-walled, nodose-septate hyphae and unbranched fibre hyphae. Carpophores of *Fomes cajanderi* lack "binding hyphae" and instead have thick-walled, nodose-septate hyphae with irregularly thickened walls which are not present in the carpophores of *Trametes suaveolens.* Any similarity between the two species, is thus entirely superficial.

Overholts (1953) transferred *Fomes cajanderi* (as *Trametes subrosea* Weir) to the genus *Fomes* (Fr.) Kickx on account of its stratified pores. Teixeira (1962 a) in a study of three species of *Fomes* (Fr.) Kickx which included the type, *Fomes*

fomentarius (L. ex Fr.) Kickx, showed that the carpophores of species of this genus have solid or sub-solid, aseptate "binding hyphae" in addition to unbranched fibre hyphae and thin-walled nodose-septate hyphae in the context, but lack the nodose-septate hyphae with irregularly thickened walls which are present in carpophores of *Fomes cajanderi*. Furthermore, the upper surface of *Fomes fomentarius* is completely different from that of *Fomes cajanderi*. Because of these differences, *Fomes cajanderi* thus cannot be regarded as congeneric with *Fomes fomentarius*.

Bondartsev & Singer (1941), Bondartsev (1953) and Kotlaba & Pouzar (1957) included *Fomes cajanderi* Karst. in the genus *Fomitopsis* Karsten together with the type species *Fomes pinicola* (Sw. ex Fr.) Cooke. There are however great differences in hyphal characters between these two species. Carpophores and cultures of *Fomes pinicola* lack the nodose-septate hyphae with irregularly thickened walls which are present in the carpophores and cultures of *Fomes cajanderi*. Furthermore, the fibre hyphae of *Fomes pinicola* are seldom branched and very slightly intertwined. The rigidity of the carpophore is due to a certain amount of agglutination of the hyphae. This is not evident in carpophores of *Fomes cajanderi* which are thus more complex in construction and of different texture. A certain amount of similarity in the nature and construction of the crustose upper surface of certain specimens of *Fomes cajanderi* and those of *Fomes pinicola* is evident. Lohwag (1940), however, reported similarities in the upper surfaces of *Fomes pinicola* and a number of other species of the genus *Ungulina* Pat. which were later placed in different groups on the basis of their hyphal and cultural characters by Nobles (1958 b). Therefore, the similarity in the upper surfaces of the carpophores of *Fomes cajanderi* and *Fomes pinicola* must be regarded as of lesser importance than the dissimilarity in their hyphal characters and *Fomes cajanderi* cannot be regarded as congeneric with *Fomes pinicola*.

Kotlaba & Pouzar (1957) suggested that *Fomes cajanderi* is transitional between *Fomitopsis* Karst. and *Coriolellus* Murr. From the above descriptions and discussions it is clear that there are few similarities between *Fomes cajanderi* and *Fomes pinicola*. Sarkar (1959) showed that six species of the genus *Coriolellus* Murr., including the type species, *Coriolellus sepium* (Berk.) Murr. which also have the cultural characters of Group 25 (Nobles, 1958 b) have hyphal characters and carpophores constructed very much like those of *Fomes cajanderi*, but she described the thick-walled, nodose-septate hyphae, which she called "incompletely differentiated fibre hyphae", in the carpophores of these species of *Coriolellus*. Such hyphae, which appear to be sclerified generative hyphae (Donk, 1964), were not found in the carpophores of *Fomes cajanderi*.

The carpophores of *Fomes cajanderi* thus differ from those of these species of *Coriolellus* Murr. in respect of the types of hyphae present in them. On the other hand, it was shown before, that many similar characters and structures exist in carpophores of *Daedalea quercina* L. ex Fr., the type of the genus *Daedalea* Pers. ex Fr., and *Coriolellus sepium* (Berk.) Murr., the type of the genus *Coriolellus* Murr. It was suggested that the six species of *Coriolellus* Murr. as described by Sarkar (1959), and which included the type species, should be included in the genus *Daedalea* Pers. ex Fr. The carpophores of *Coriolellus sepium* (Berk.) Murr., however, differ from those of *Daedalea quercina* L. ex Fr. in the same characters as carpophores of *Fomes cajanderi* differ from those of *Daedalea quercina*. In cultural characters too, there is as much similarity between cultures of *Fomes cajanderi* and *Daedalea quercina* as exists between cultures of the latter species and those of *Coriolellus sepium*. For these reasons it seems safe to suggest that *Fomes cajanderi* Karst. should be included in the genus *Daedalea* Pers. ex Fr.

Resumé.

The four species of polypores included in Group 25 in the present study have many characters in common. In the cultures and carpophores of all four species, thin-walled, nodose-septate hyphae and nodose-septate hyphae with irregularly thickened walls are present together with aseptate, thick-walled fibre hyphae which are mostly unbranched. Their basidiospores are cylindrical. Their relatively thick, anoderm carpophores have thick dissepiments and are similar in construction. Their cultures do not produce extra-cellular oxidase enzymes and they all cause brown rots in their respective hosts. They differ from each other in respect of hymenial configuration, carpophore texture and host preferences. These appear to be minor differences however which are overshadowed by the many similar characters in these species. It thus appears that these species may be regarded as congeneric with the type species of the genus *Daedalea* Pers. ex Fr.

5.6 Group 32

Cultures of species in this group form white mycelial mats which produce extra-cellular oxidase enzymes. Their thin-walled hyphae have simple clamp connections at the septa and are undifferentiated except for occasional swellings or incrusted portions. Their basidiospores are sub-globose to ovoid or ellipsoid and less than 8μ in length. Their interfertility is of the tetrapolar type.

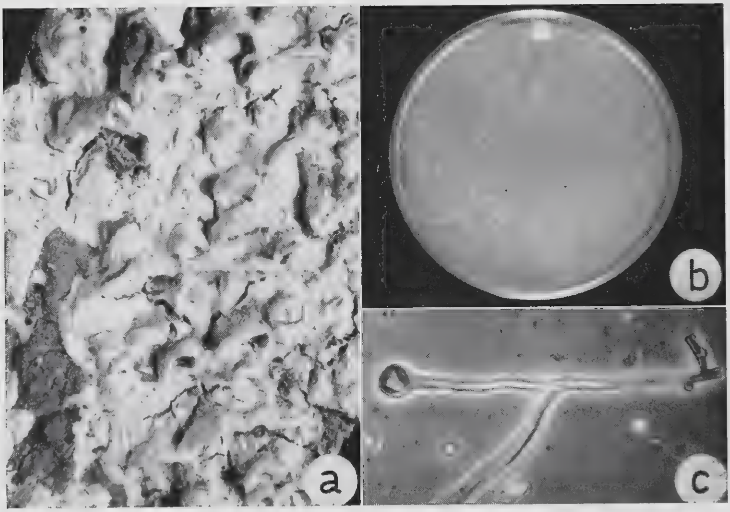

Fig. 19. — **Polystictus subiculoides.** (a) Carpophore of PRE 35331; (b) culture of PRE 42155 at six weeks; (c) vesicle on thick-walled, nodose-septate hypha from carpophore, × 500 phase contrast.

Polystictus subiculoides *Lloyd*, C. G., in Mycological Notes No. 73, 1331, 1924.

Cultural characters

Growth is moderately fast the mat reaching a radius of 50 mm after two weeks and covering the plates in 3 to 4 weeks; margin even to slightly bayed, hyphae raised to limit of growth; mat white, thin, downy to cottony, azonate, with

a smooth, even, radially combed appearance and remaining so for many weeks; reverse bleaching slowly after two weeks. Oxidase reaction positive with gum guaiac solution; weak diffusion zone and slow growth, colony diameter 10 mm after one week on gallic acid agar, no growth or diffusion zone on tannic acid agar. *Advancing mycelium:* hyphae hyaline, unbranched or branching, nodose-septate, thin-walled, 2.2 — 4.5μ in diameter (Fig. 20 a).

Aerial mycelium: (a) hyphae as in the advancing zone; (b) vesicles obovate or pyriform, hyaline, 7 — 10 x 15 — 20μ arising terminally on short lateral projections from hyphae (Fig. 20 b); (c) narrow thin-walled, hyaline nodose-septate hyphae, 1.5μ in diameter, with sub-globose, terminal vesicles 3.0 — 5.0μ in diameter (Fig. 20 c).

Submerged mycelium: hyphae as in the advancing zone but more frequently septate. Crystals hyaline, amorphous, numerous in the medium.

Carpophore characters.

Carpophore annual, lignicolous; pilei small, sessile to effused-reflexed, imbricate, often connate and arising from broad subiculum, soft corky, drying to hard corky 0.1 — 0.4 x 0.3 — 1.2 x 0.1 — 0.2 cm; surface minutely pubescent, smooth or slightly rugose, azonate, acuticulate, "cream color" or with small "cinnamon" patches; margin thin, acute, entire, concolorous with surface; pore surface concolorous or slightly buff coloured, poroid; pores angular, 4 — 7 per mm, mouths entire, dissepiments thin, decurrent on the subiculum, tubes 0.5 — 3 mm deep. Context white to pale "cream color" drying isabelline, up to 3.0 mm thick.

Hyphal characters: hyphae hyaline, branched nodose-septate with clamp connections often on one side only, thin-walled in young parts (Fig. 20 e); vesicles thin-walled, ovoid or sub-globose 4.5 — 12.0μ in diameter borne terminally on short lateral or terminal hyphae, arising at clamp connections (Fig. 19 c, 20 f).

Hymenium: basidia hyaline, broadly clavate, 8 — 12 x 4.5 — 6.0μ with four short straight sterigmata 1.5 — 2.2μ (Fig. 20 h); basidiospores hyaline sub-globose to ovoid, smooth, thin-walled 3.0 — 3.5 x 3.2 — 4.2μ (Fig. 20 k); vesicles as in the context, occasionally incrusted, small; acicular, encrusted hyphal tips projecting into hymenium narrow, 1.5 — 2.5 x 12 — 20μ (Fig. 20 n).

Construction. The cream-coloured subiculum which is up to 5 mm thick consists mainly of hyaline, thick-walled, nodose-septate hyphae together with thin-walled, nodose-septate hyphae, somewhat intertwined, and growing perpendicularly out of the substrate, with vesicles scattered throughout the subiculum and hyphal contents discoloured at different levels to form the darker zones visible in vertical section.

The pilei are formed by thick-walled, nodose-septate hyphae which grow out beyond the level of the subiculum and by repeated branching form intertwining hyphae which turn upward towards the upper surface of the pilei where their ends are densely packed at a common level to form the pubescent upper surface. In the same way these thick-walled, nodose-septate hyphae turn downward and by repeated branching produce intertwining hyphae which form the lower context. In the trama of the tubes the branches of these hyphae are mostly thin-walled, short and form a dense, even layer which bear the small basidia on the hymenial surfaces lining the cavities of the tubes only. In the lower context vesicles are more numerous than in the upper context. The margins of the pilei consist of the terminal sections of thick-walled, nodose-septate hyphae from the context, mostly unbranched, often somewhat elongated to over 100μ in length and resembling short, fibre hyphae with thin-walled tips (Fig. 20 g).

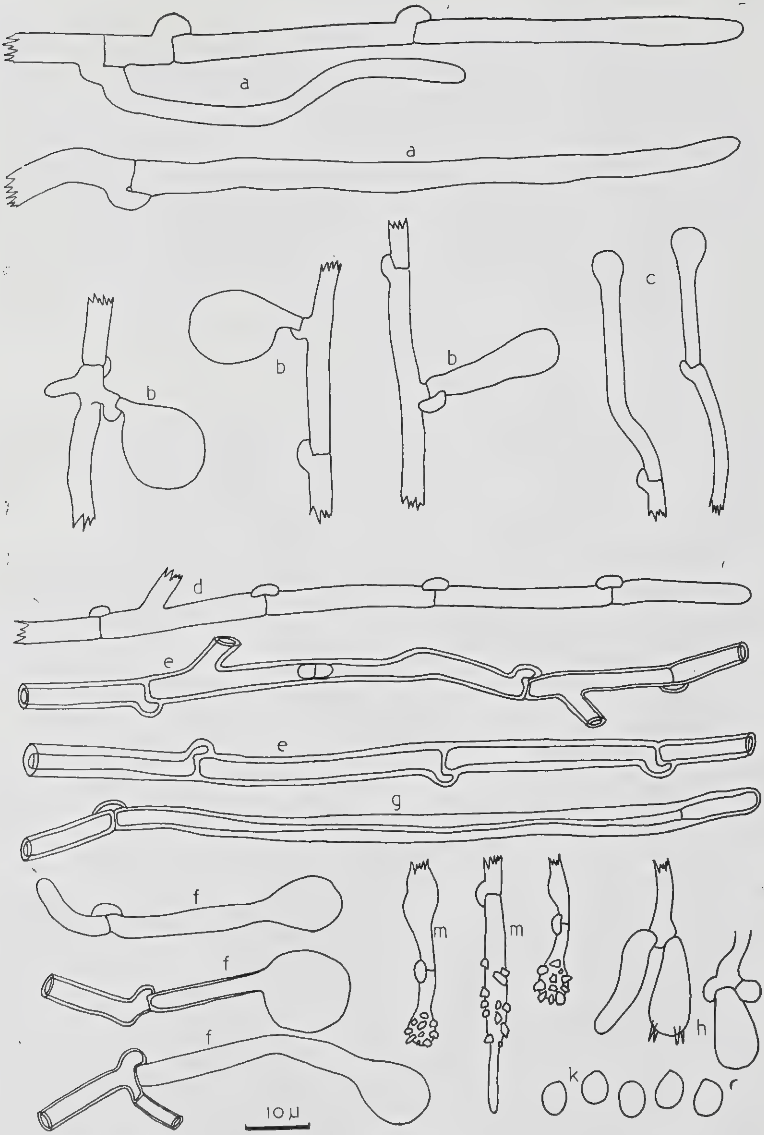

FIGURE 20.

FIG. 20.— **Polystictus subiculoides.** a - c. Structures from cultures: (a) thin-walled, nodose-septate hyphae from advancing zone; (b) lateral vesicles; (c) terminal vesicles.

d - m. Structures from carpophores: (d) thin-walled, nodose-septate hyphae from margin; (e) thick-walled, nodose-septate hypha from context; (f) hyphae with terminal vesicles; (g) thick-walled nodose-septate hypha with lengthened, terminal cell; (h) basidia; (k) basidiospores; (m) acicular and vesicular encrusted hyphal tips.

Decay and hosts

Polystictus subiculoides causes a white rot of living hard-wood trees and dead deciduous and coniferous wood.

Specimens examined.

Herb. PRE: 1357, on *Grevillea robusta,* Pietermartizburg, Natal, April 1911, (TYPE); 27651, on bark of dead stump, Pietermaritzburg, Natal, 1934; 27775, Pietermaritzburg, Natal, 1934; 28649, indigenous wood, Pietermaritzburg, Natal, Sept. 1934; 28472, on *Grevillea robusta,* Pietermartizburg, Natal, Sept. 1934; 28556, on gum tree, Pietermartizburg, Natal, Sept. 1934; 28559, on *Acacia mollissima,* Impolweni, Natal Sept. 1934; 28772, on *Quercus* sp., Johannesburg, 1936; 30171, on indigenous wood, Umgeni Forest, Natal, March 1935; 30179, on indigenous wood, Umgeni Forest, Natal, March 1935; 30742, on bark, Deepwalls, Knysna, Apr. 1939; 35331, on *Quercus* sp., Pietermaritzburg, Natal, 1943; 36692, on *Acacia* sp. stump, Lions River, Natal, May 1948; 39195, Pietermartizburg, Natal, Jan. 1946; *42155, on *Bridelia macranthra,* F. C. Erasmus Nat. Reserve, Feb. 1961; *42157, on dead stump, F. C. Erasmus Nat. Res. Tvl., Feb. 1961; 42199, on dead wood, Pretoria, Nov. 1961; 42291, on dead *Pinus* sp., Saasveld, C.P., Nov. 1962; *42359, on dead *Pinus* sp., Entabeni Forest Reserve, Tvl., Apr. 1964.

Discussion

Polystictus subiculoides has not been described in culture before. Cultures of this species are distinguished by the weakly positive oxidase reaction, hyaline-white, radiating, silky, mycelial mat, and thin-walled, nodose-septate, undifferentiated hyphae bearing thin-walled vesicles on short, lateral branches. As the terminal vesicles may be conveniently regarded as swellings of the hyphae a basis for the inclusion of *Polystictus subiculoides* in Group 32 is provided, but this species is not well placed in Group 32 because the lateral vesicles are not simple swellings on hyphae and as no provision is made other than for undifferentiated nodose-septate hyphae and differentiated fibre hyphae, no other alternative group is available in which this species may be better placed.

Vesicles are regarded as gloeocystidia by Lentz (1954), Talbot (1954 a) and Van der Westhuizen (1958) but the characteristic staining reaction for gloeocystidia was not seen when mycelium from a growing culture of *Polystictus subiculoides* was mounted in sulphuric-anisaldehyde and sulphuric-benzaldehyde as used by Slysh (1960) for species of *Peniophora.* The vesicles of *Polystictus subiculoides* thus do not appear to be gloeocystidia. Allocysts were described from cultures of *Flammula alnicola* and *Flammula conissans* by Denyer (1960). The vesicles of *Polystictus subiculoides* resemble these allocysts very closely.

Nobles (1965) included *Flammula alnicola* and *Flammula conissans* under Key Code 2.3.26 of a key devised as an aid for the identification of cultures of Basidiomycetes isolated from decayed wood. As cultures of *Polystictus subiculoides* have a positive reaction for extra-cellular oxidase, consistently nodose-septate, thin-walled hyphae, and "swellings on hyphae" similar to those of *Flammula alnicola* and *Flammula conissans, Polystictus subiculoides* may be included in Key Code 2.3.26. Cultures of *Polystictus subiculoides* may be distinguished from cultures of these two *Flammula* spp. by the higher growth rate and more uniform texture of the mat together with the geographical distribution of the species.

Cultures of *Collybia velutipes, Aporpium caryae, Polyporus volvatus* and *Polyporus fumosus* were also included by Nobles (1965) in Key Code 2.3.26. Cultures of these species may however be readily distinguished from those of *Polystictus subiculoides* as they lack the characteristic vesicles of this fungus. Cultures of *Polystictus subiculoides* also resemble those of *Odontia bicolor* (Nobles, 1953) in many ways but differ by having thinner, silky mycelium while the vesicles of *Polystictus subiculoides* are larger than the cystidia of *Odontia bicolor* and lack the latter's typical, large crystalline incrustations.

The carpophores of *Polystictus subiculoides* are most interesting morphologically as well as anatomically. The pilei arise as reflexed portions of a well-developed subiculum. The pilei are integral parts of the subiculum and, except for the presence of hymenial layers in the minute tubes, anatomically undifferentiated and virtually indistinguishable from it microscopically. Both structures are remarkable for their simple construction of nodose-septate hyphae with partly thickened walls, arranged more or less parallel to one another and perpendicular to the substrate. Of all the species included in this study, *Polystictus subiculoides* has the simplest construction of its pilei and the least differentiation in morphology and function of its hyphae.

From the descriptions it is evident that only one type of hypha is found in both the cultures and carpophores. The vesicles which are so characteristic in the cultures, are found throughout the tissues of the carpophores and subiculum. Differences in the thickness of the walls of hyphae from the cultures and hyphae from the carpophores had been seen in other species as well (cf. Groups 7 & 9) and appears to be a modification which usually occurs under natural conditions during fruit-body formation. All structures formed in cultures are thus present in the carpophores as well.

Few species of poroid Hymenomycetes are known to have similar vesicles or gloeocystidia in their carpophores. Notable among these are *Poria versipora* (Pers.) Romell (Cunningham, 1946; Lowe, 1946) and *Polyporus borealis* Fr. (Ames, 1913; Overholts, 1953). These structures are found in *Poria versipora* in the hymenium only but they are present in the context of specimens of *Polyporus borealis*. Nobles (1958 b) placed cultures of these species in Group 32, but did not indicate whether vesicles were formed. Since the other species in Group 32 are known to form vesicles in culture, it is assumed that *Poria versipora* and *Polyporus borealis* agree in this respect with the other species and that the vesicles formed in their carpophores are ontogenetically or physiologically different from those of *Polystictus subiculoides*.

Pilát (1946) described conical, immersed cystidia in carpophores of *Poria fissiliformis* and Nobles (1958 b) included cultures of this species in Group 32, but this species differs from *Polystictus subiculoides* by having fibre hyphae in its carpophores.

Vesicles and gloeocystidia of various forms are present in the cultures and carpophores of many species of lower Hymenomycetes notably in the genera *Corticium* Pers ex Fr. *Odontia* Fr., *Peniophora* Cke. and *Stereum* Pers. ex Gray (Lentz, 1954; Talbot, 1954 a; Nobles, 1948, 1965; Cunningham, 1963). In *Odontia bicolor* capitate vesicular gloeocystidia are formed in cultures (Nobles, 1953) and in the spines of the carpophore (Talbot, 1958 b). In *Peniophora utriculosa* G. H. Cunn. the small deeply-staining vesicles are borne on short lateral branches of the intermediate layers of the fruit-body, and are not subtended by clamp connections (Cunningham, 1963). In *Peniophora vesiculosa* G. H Cunn. and *Peniophora utriculosa* G. H. Cunn. the vesicles are larger and subtended by clamp connections and situated in the intermediate layers of the carpophores. In both species encrusted metuloids are also present in the tissues (Cunningham, 1963). The vesicles of *Stereum purpureum* are also present in the intermediate zone of the fruit-body but this fungus differs from the others by having fibre hyphae in culture (Van der Westhuizen, 1958) and in the carpophore (Talbot, 1954; Cunningham, 1963). These species of these three genera agree in the morphology and positions of the vesicles in the tissues of their carpophores. The vesicles of *Polystictus subiculoides* are similar in morphology and disposition in the tissues to the vesicles of these four species. The carpophores also show similarities with those of the thelephoraceous

species by virtue of their simple construction of one type of hypha only. *Polystictus subiculoides* also occurs mainly on angiosperm wood and has a weakly positive oxidase reaction. These similarities appear to indicate that *Polystictus subiculoides* has affinities with these species and should be regarded as a poroid member of a group of Hymenomycetes with thelephoraceous carpophores.

5.7 Group 45

The cultures of species in this group form mycelial mats which mostly remain white or develop patches of pale, bright colours. Extra-cellular oxidase enzymes are produced. Their thin-walled hyphae have simple clamp connections at the septa and usually remain thin-walled but thick-walled, aseptate, fibre hyphae are formed in large numbers. Their basidiospores are cylindrical and their interfertility is of the tetrapolar type.

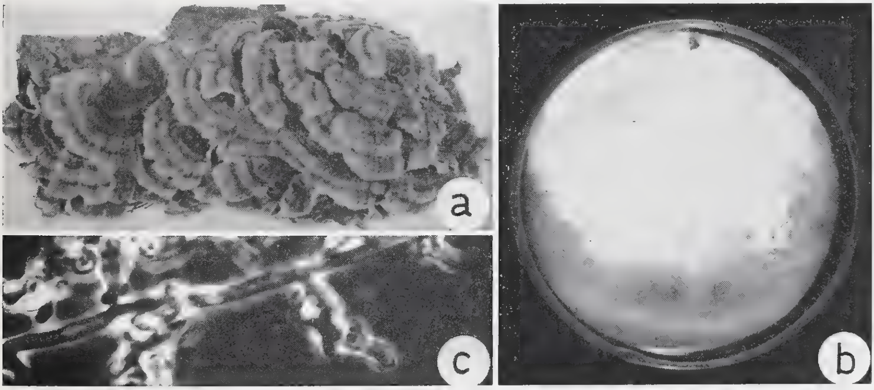

Fig. 21.— **Polyporus versicolor.** (a) Carpophores of DAOM 83052; (b) culture of PRE 42370 at six weeks; (c) nodose-septate hypha with irregular projections from culture, × 500 phase contrast.

Polyporus versicolor *L. ex Fr.*, Syst. Mys. 1, 368, 1821;
Coriolus versicolor (L. ex Fr.) Quél., Ench. Fung., 175, 1886;
Trametes versicolor (L. ex Fr.) Pilát, Atl. Champ. Eur. III, 261, 1939.

Cultural characters

Growth is rapid to moderately rapid the colonies reaching radii of 30 — 50 mm in one week and covering the plates in two to three weeks. The margin is even, appressed, thin, hyaline. Behind the margin the young mat may be raised, cottony, with vague radiating grooves, or floccose, or finely farinaceous, white, but becoming collapsed over the older part where thin, pellicular patches of dense mycelium start forming after 2 — 3 weeks. The pellicular areas become sub-felty, increase in size and coalesce while in some parts they change from white or "cream color" to smooth, hard, crustose areas of various shades of brown, turning finally "saccardo's umber" or "sepia." In some isolates these pellicular areas may become more felty and increase in thickness eventually developing "natal

brown" or "saccardo's umber" patches. In others the pellicular areas never develop but the mat remains thin, white, downy-farinaceous with fine, white, farinaceous striae radiating from the inoculum. Fruiting may occur in some cultures. Shallow, smooth depressions appear on dense, pellicular areas of mycelium or on rounded lumps of dense mycelium. Minute, acicular projections develop in these depressions, bearing normal, fertile basidia and basidiospores. A white spore deposit is soon formed under these structures in inverted cultures. The reverse is bleached after two to four weeks but patches of "wood brown", "army brown" or "natal brown" may develop in the agar under the coloured areas. Odour may be strong mushroomy or somewhat unpleasant, fishy.

On gallic and tannic acid agars the diffusion zones are dark and wide while growth of mycelium extends up to 2.0 cm and 3.0 cm in diameter on gallic acid and tannic acid media respectively. When an alcoholic solution of gum guaiac is applied to the mycelium the colour changes rapidly to bright blue.

Advancing mycelium: hyphae hyaline, branching, thin-walled, nodose-septate, with deeply staining contents, 2.0 — 4.0μ in diameter (Fig. 22 a).

Aerial mycelium: (a) hyphae as in the advancing zone; (b) fibre hyphae long, unbranched hyaline, sub-solid to solid with the lumina visible mostly at the tapering ends only, up to 4.5μ in diameter at the widest part, (Fig. 22 b); (c) fibre hyphae long, narrow, hyaline, branching repeatedly the branches long and flexuous and tapering towards the ends, 1.2 — 3.0μ in diameter, (Fig. 22 c); (d) nodose-septate hyphae with slightly thickened, hyaline walls and without contents, 2.5 — 3.5μ in diameter, and with many, short, lateral branches, either thick-walled or solid and refractive, and stained brown by a lacquer-like substance secreted in the brown areas (Fig. 21 c, 22 d); (e) nodose-septate hyphae with thickened, brown walls, 2.5 — 3.5μ in diameter, embodied in brown, resin-like material present in the brown areas (Fig. 22 e); (f) very narrow, hyaline hyphae, 0.5 — 0.8μ in diameter and profusely, dichotomously branched, forming a network among the other hyphae in the pellicular areas.

Fructifications: basidia clavate, hyaline, 12.0 — 20.0 x 3.6 — 4.6μ with four long, slender, somewhat curved sterigmata, 2.8 — 3.3μ; basidiospores hyaline, cylindrical, slightly curved, rounded at the ends, obliquely apiculate, smooth, thin-walled, 4.2 — 5.4 x 1.8 — 2.2μ (Fig. 22 f); occasionally branched cystidioles present among the basidia.

Submerged mycelium: (a) nodose-septate hyphae as in the advancing zone; (b) nodose-septate hyphae with thickened, brown walls and numerous, short, lateral branches as in the aerial mycelium.

Carpophore characters

Carpophore annual often reviving, lignicolous, grouped or compound; pileus dimidiate, sessile, often with a reduced base, or, effused-reflexed, occasionally imbricate, laterally connate or forming rosettes, up to 6.0 x 8.0 x 0.1 — 0.3 cm; tough, coriaceous, drying to hard coriaceous; surface velutinate to villose, concentrically zonate with alternate zones finally glabrous, and zones variously coloured

FIG. 22.—**Polyporus versicolor.** L. ex Fr. a - f. Structures from cultures: (a) hyphae from advancing zone; (b) unbranched, fibre hyphae; (c) fibre hyphae with long, flexuous branches; (d) nodose-septate hyphae with numerous, thick-walled or solid, lateral branches; (e) thick-walled, brown, nodose-septate hyphae; (f) basidia and basidiospores.
g - p. Structures from carpophores: (g) thin-walled, nodose-septate hyphae; (h) tuft of agglutinated, thick-walled, nodose-septate hyphae; (k) fibre hyphae; (m) fibre hyphae with short, tortuous, lateral branches; (h) fibre hyphae with long, tapering branches; (p) basidia and basidiospores.

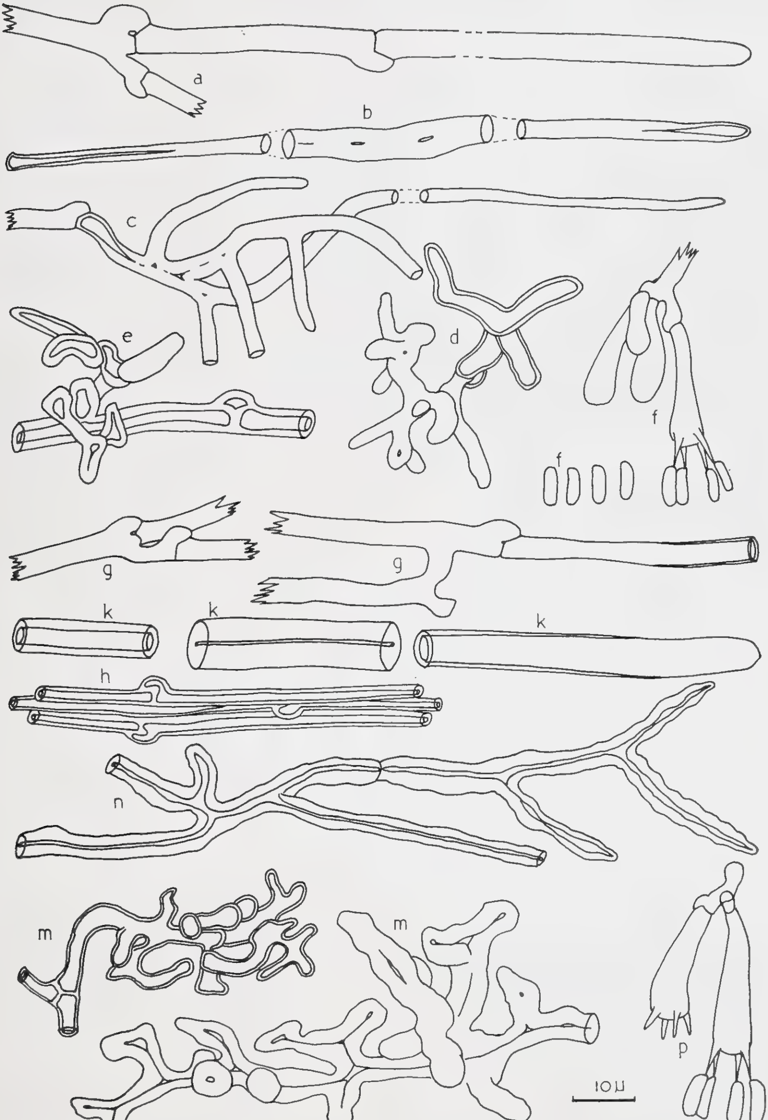

FIGURE 22.

from white to yellow brown, reddish, greenish, blueish and blackish; margin acute, entire, occasionally undulate or lobed, white or pale yellowish; pore surface white or pale cream drying to deep cream or brownish yellow, often glistening; pores 3 — 5 per mm, angular, entire; dissepiments even, thin-walled, tubes concolorous or pale up to 2 mm deep. Context white or pale cream-coloured, floccose, thin, 0.5 — 2.5 mm.

Hyphal characters: (i) nodose-septate hyphae hyaline, branching freely, thin-walled, contents staining deeply, 2.0 — 3.5μ in diameter (Fig. 22 g); (ii) nodose-septate hyphae mostly agglutinated into tufts or strands the walls at first hyaline, soon pale brown, thickened, the lumina narrowed to two thirds or one half the total diameter of the hyphae, and with deeply staining contents, 1.5 — 2.4μ in diameter (Fig. 22 h); (iii) fibre hyphae long, straight, unbranched, hyaline with thick refractive walls and lumina wide at the tips, but narrowed along the middle sections where they are visible as thin interrupted lines only, aseptate or with an occasional simple septum near the tips, contents usually deeply staining often discoloured to brownish or dark brown towards the distal ends, 3.0 — 8.0μ in diameter (Fig. 22 k); (i) fibre hyphae short, with numerous short, intricately flexuous lateral branches, hyaline, with walls thickened and lumina narrowed, with deeply staining contents, aseptate, or solid, 1.5 — 3.0μ in diameter and arising from thin-walled, nodose-septate hyphae (Fig. 22 m), binding hyphae sensu Corner (1932 b); (v) fibre hyphae with fairly numerous branches, the branches mostly long and tapering rather abruptly at the tips, or similar to the "binding hyphae", the walls thickened, hyaline, the lumina narrow but prominent with deeply staining contents, aseptate, 2.2 — 3.2μ in diameter (Fig. 22 n).

Hymenium: basidia short, hyaline, narrowly clavate, 9.0 -- 15.0 x 3.6 — 4.5μ, with four, straight, slender sterigmata, 1.5 — 2.5μ (Fig. 22 p); basidiospores long, cylindrical, slightly curved or allantoid, hyaline, smooth, thin-walled, 4.5 — 6.5 x 1.2 — 2.0μ (Fig. 22 p); hyphal pegs broadly conical, sterile, projecting up to 40μ beyond the level of the hymenium, not numerous.

Construction. The margin consists mainly of hyaline, long, unbranched, fibre hyphae mostly with fairly wide lumina and arranged more or less parallel to and slightly intertwined with one another. In between them are numerous fibre hyphae with partly thickened walls and a profusion of short, contorted branches growing across the direction of growth of the fibre hyphae and binding them together into a tough tissue. Both these types of hyphae arise from branches of narrow, thin-walled, nodose-septate hyphae with deeply staining contents, which are interwoven with the other two types. Behind the margin the upper context is similar in construction but the fibre hyphae develop thicker walls and lumina are narrower. Much branched fibre hyphae (binding hyphae), mostly solid, are abundant towards the upper surface, where they bind the long fibre hyphae and numerous branching, thin-walled, nodose-septate hyphae into a tough, dense, layer of tissue up to 60μ thick and coloured brownish by a resinous or lacquer-like substance. Through this layer the ends of long fibre hyphae from the context protrude to form the pubescence of the upper surface. Most of these fibre hyphae have brownish contents of the lumina which widen gradually towards the rounded ends (Fig. 22 k). Arising from thin-walled, nodose-septate hyphae in this dense layer, are numerous narrow, thick-walled, nodose-septate hyphae, with the walls pale brown and luminal contents staining deeply. These hyphae are either agglutinated into tufts or strands (Fig. 22 h) or closely appressed to and agglutinated with fibre hyphae into tufts by means of a brown, lacquer-like substance. The smooth, brown zones of the upper surface are formed by this brown, lacquer-like substance agglutinating the fibre hyphae and nodose-septate hyphae into a brown, smooth cuticle of resupinate elements.

Below this dense upper layer the context tissues are less dense consisting of long, unbranched, hyaline, solid or sub-solid, fibre hyphae in more or less parallel arrangement, small numbers of thin-walled, nodose-septate hyphae and intertwined with hyaline, fibre hyphae (binding hyphae) with long, flexuous branches with characteristically tapering ends (Fig. 22 n).

The lower context is like the middle context but the fibre hyphae (binding hyphae) with numerous short, hyaline, solid, branches (Fig. 22 m) become very numerous and form a dense layer. From the lower context, long unbranched fibre hyphae turn downward into the dissepiments and become flexuous, narrower and tightly intertwined, with numerous "binding hyphae" of the short, much branched type as well as the other type with longer branches and which may become indistinguishable from the short type, into a very tough and dense tissue. In between the fibre hyphae, numerous thin-walled, nodose-septate hyphae, with deeply staining contents and branching repeatedly, are present. At the surfaces of the dissepiments, the branches of the nodose-septate hyphae bear the basidia in a dense, even stand.

The hyphal pegs in the hymenium consist of the ends of fibre hyphae, in parallel arrangement, projecting into and beyond the hymenium from the underlying tissue.

Decay and hosts.

Polyporus versicolor causes a white rot of dead wood of a wide variety of species of deciduous trees.

Specimens examined

Herb. DAOM: *F8183, on *Juglans* sp. Saanichton, B.C., June 1938; 11781, on decayed wood, Burnet, Que., Aug. 1944; 11782, on hardwood, Gatineau Park, Que., Aug. 1944; *11783, on *Betula* sp. Gatineau Park, Que., Aug. 1944; *21150, on *Betula papyrifera* log, Dorset, Ont., July 1948; 21196, on decayed *Acer* log, Dorset, Ont., July 1948; *21767, on decayed *Podocarpus spectatus*, Rotorua, N.Z., Nov. 1948; *22296, on *Alnus rubra*, Cowichan Lake, B.C., June 1948; 22342, on decayed hardwood, Ottawa, Sept. 1949; 22348, on deciduous host, ex herb. J. Pinto-Lopes, April 1950; 22357, on *Eucalyptus* sp. ex herb. J. Pinto-Lopes, April 1950; *22586, on *Eucalyptus*, Seven Oaks, Surrey, Sept. 1950; *22794, on roots of *Betula lutea*, Bells Corners, Ont., July 1949; *30588, on *Quercus robur* stump, Norway, Nov. 1953; *30589, on *Acer* sp., Norway, Nov. 1953; *31926, on *Betula papyrifera*, Calabogie, Ont., Aug. 1955; 52102, Gainesville, Fla., Sept. 1954; *53899, on dead wood, Wakefield, Que., July 1952; 53900, on *Acer* sp., Cantley, Que, July 1952; *69694, on hardwod, Walker, La., Aug. 1960; 72326, on deciduous wood, Sargent Camp, N.H., Aug. 1956.

Herb. PRE: 1332, on *Acacia decurrens*, Pietermartizburg, Natal, Apr. 1911; 14838, Kirstenbosch, C.P., June 1929; 20603, Knysna, C.P., Jan. 1925; 21877, on *Fagus* sp., Krieger, Schädliche Pilzen, Sept. 1905; 22072, Boschberg, C.P. Sept. 1876; 22857, Falkenburg, Germany, Sept. 1873; 23482, Mont-aux-Sources, Natal, 1937; 24202, Hollos, Hungarian Fungi No. 320; 24830, dead logs, Kirstenbosch, C.P., June 1929; 24847, on stumps, Kirstenbosch, C.P., June 1929; 27278, Groote Schuur, C.P., Aug. 1933; 27608, Town Bush Valley, Pietermartizburg, 1934; 28754, dead wood, Pilgrim's Rest, Tvl., Oct. 1936; 30522, Pretoria, Tvl., Feb. 1939; 30722, dead wood, Pretoria, Tvl., 1939; 30726, Xumeni Forest, Natal, 1937; 30739, Deepwalls, C.P., April 1939; 30848, Margawa Forest, Natal, June 1939; 31336, Town Bush Valley, Pietermartizburg, June 1939; 31427, old logs, Stellenbosch, C.P., Sept. 1919; 31429, Stellenbosch, C.P., Sept. 1919; 31550, Moodies, Natal, August 1915; 34071, dead wood, Mariepskop, Tvl., May 1943; 35651, dead wood, ex Herb. Hort. Bot. Reg., Kew, Oct. 1938; 36874, dead wood, Umtali, S.R., July 1948; 41536, dead wood, Hogsback, C.P., May 1956; *42370, on maple log, Packenham, Ont., June 1962; *42813, on dead wood, Stellenbosch, C.P., Aug. 1959; *42956, on hardwood stump, Warrensburg, N.Y., Aug. 1962.

Herb. STE: 124, Kirstenbosch; 159, on *Salix* sp. log, Nottingham Rd., Natal; 199, on dead stumps and logs, Natal Midlands; 291, on dead stumps and logs, Barberton, Tvl.; 714, op dooie hout, Knysna, Jan. 1922; 882, on *Alnus tenuifolia* ex Herb. J. R. Weir; 1480, droë hout, Houtbos, Tvl., Julie 1924; 2647, on *Alnus tenuifolia*, ex Herb. C. J. Humphrey.

Discussion

The cultural characters as described above, agree well with the descriptions by Fritz (1923), Jay (1934), Refshauge & Proctor (1936), Davidson, Campbell & Vaughn (1942), Cartwright & Findlay (1946) and Nobles (1948, 1965). The thick-walled, brownish, nodose-septate hyphae and the short hyphae with numerous, short, lateral branches have not been reported before. These hyphae do not form wrinkled, pseudoparenchymatous, crustose areas which are characteristic of cultures of the species in Nobles' Group 53 (1958 b) although there appears to be some superficial resemblance to "hyphae with interlocking projections" (Nobles 1948, 1958 b). Instead, these hyphae from the cultures of *Polyporus versicolor* are found mostly in the mycelial mat among the fibre hyphae or occasionally agglutinated with brown, lacquer-like material in brown areas of some isolates of this species (Nobles, 1965). In view of their position, morphology and development and the fact that the binding hyphae in the carpophores of *Polyporus versicolor* apparently develop in the same way, they are regarded as homologous with the binding hyphae, which are so numerous in the carpophores of *Polyporus versicolor*. These structures are quite characteristic and may serve to distinguish this species from others in this group of which the cultural characters are otherwise very similar.

From the description it is evident that the carpophores of *Polyporus versicolor* consist of five kinds of hyphae. Thin-walled, nodose-septate hyphae are present in the growing regions and hymenial areas while thick-walled, nodose-septate hyphae are associated with the unbranched fibre hyphae on the upper surface and in other parts of the context where they bind other hyphae into tough, dense tissue. The branched fibre hyphae of the lower context together with the branched, tortuous, binding hyphae constitute the binding system in the lower part of the tissues. The carpophores thus have a trimitic hyphal system with generative, skeletal and binding hyphae as reported by Cunningham (1948 c), Teston (1953 b), Kotlaba & Pouzar (1957), Teixeira (1960) and Farinha (1964), but these authors, with the exception of Teixeira (1960) and Farinha (1964), who described thick-walled, nodose-septate hyphae from carpophores of *Polyporus versicolor*, mentioned only three kinds of hyphae in the carpophores. Corner (1932 a), however, stated that such thick-walled, nodose-septate (or generative) hyphae may contribute to the binding hyphal system of some species, thus confirming the above observations. The fibre hyphae with branches towards the distal ends have not been reported from *Polyporus versicolor* before but similar hyphae, termed "arboriform hyphae" by Teixeira (1962 b) were reported from the fruit-bodies of *Ganoderma* spp. by Hansen (1958) and Furtado (1965 a) where they also assist in binding the tissues of the carpophores. In the carpophores of *Polyporus versicolor*, morphologically and ontogenically different hyphae thus contribute to the different hyphal systems of the trimitic fruit-bodies.

From the above descriptions, it is clear that most of the structures formed in cultures of *Polyporus versicolor* are also present in the carpophores from which the cultures were made. Only very narrow hyphae which form a network in the pellicular areas of the cultures, were not found in the carpophores. It is not known whether such hyphae are present in wood decayed by *Polyporus versicolor*. No decayed wood was available for study.

Polyporus versicolor is regarded as the type species of the genus *Coriolus* Quél. (Cooke, 1959; Donk, 1960). This species was transferred to the genus *Trametes* Fr. by Pilát (1936) who was followed by Kotlaba & Pouzar (1957) in this. There is indeed great similarity in hyphal characters and carpophore construction between *Polyporus versicolor* and *Trametes suaveolens* Fr. the type of the genus *Trametes* Fr. (Donk, 1960). These similarities and their implications will be discussed below.

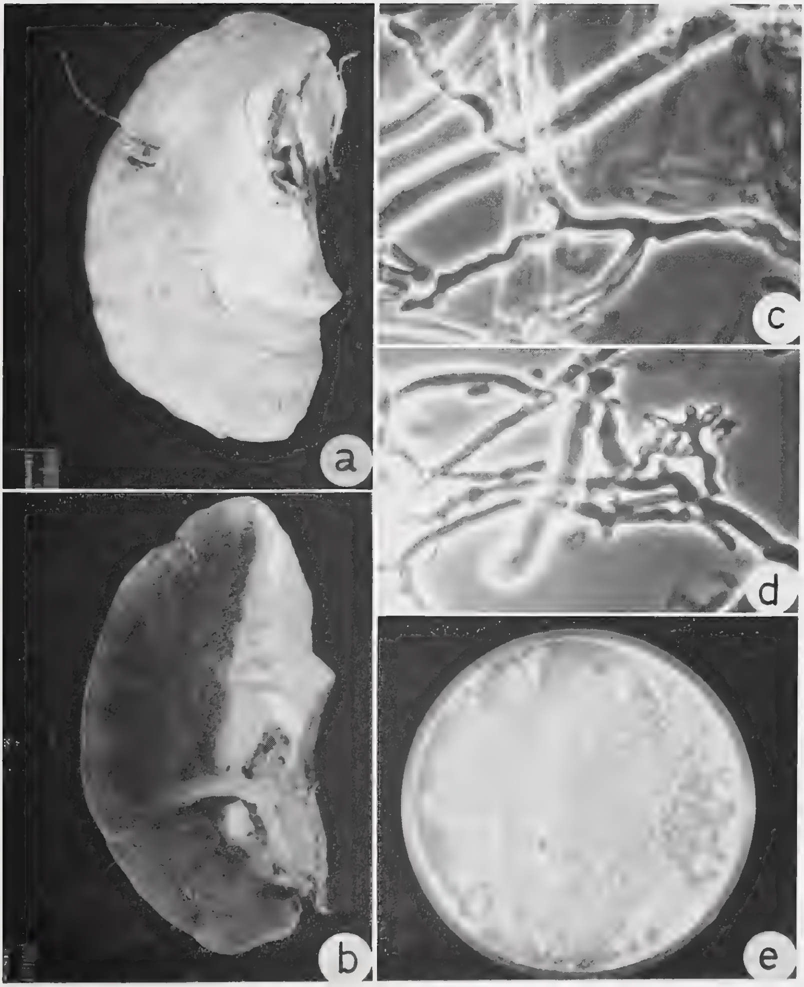

FIG. 23.— **Trametes suaveolens.** (a) Carpophore upper surface and (b) hymenial surface of DAOM 31500; (c) branched fibre hypha from upper context of fruit-body; (d) same from context above tubes, X 1000 phase contrast; (e) culture of DAOM F1964 at six weeks.

Trametes suaveolens *(L. ex Fr.) Fries,* Epicr. Syst. Myc., 491, 1838.

Cultural characters

Growth is moderately fast, the mat reaching a radius of 20 — 30 mm after one week and covering the plates in 2 to 4 weeks. Margin even, mycelium raised to limit of growth or appressed. Mycelium white, dense cottony to woolly in newest growth occasionally somewhat lacunose but collapsing in older parts, becoming more cottony and forming irregular sub-felty or woolly areas interspersed in some cultures by patches of sodden mycelium, or, mat fairly evenly thin, woolly, with elongated lumps or ridges of more compact, felty mycelium developing pale, yellowish or brownish tints and placed on vague ridges radiating from the inoculum. Around the inoculum may be an area of farinaceous-downy or farinaceous, thin, sub-felty mycelium. A ring of woolly mycelium may gradually develop against the side of the dish in some isolates. The reverse is bleached rapidly and a sweet fragrant, odour is emitted. On gallic acid and tannic acid media, strong diffusion zones are formed and a trace of growth takes place on tannic acid agar only. A strong blue colour is formed when a drop of alcoholic gum guaiac solution is applied to the culture.

Advancing mycelium: hyphae hyaline, thin-walled, with deeply staining contents, nodose-septate, branching between the septa, 2.4 — 4.5μ in diameter (Fig. 24 a).
Aerial mycelium: (a) hyphae thin-walled, nodose-septate, hyaline as in the advancing zone; (b) fibre hyphae hyaline, unbranched, solid or sub-solid, with lumina aseptate and visible only at the extremities, 2.0 — 4.0μ in diameter (Fig. 24 b), or, branching freely, often from a short main stem and tapering towards the ends, narrow, thick-walled to sub-solid in parts, 1.5 — 3.0μ (Fig. 24 c). Some fibre hyphae may have spear-shaped ends (Fig. 24 d).

Submerged mycelium: (a) nodose-septate hyphae as in the advancing zone: (b) chlamydospores terminal and intercalary, broadly ovoid to somewhat cylindrical, thin-walled or thick-walled, 7.5 — 16.0 x 4.0 — 6.0μ (Fig. 24 e).

Carpophore characters

Carpophore annual, occasionally reviving, lignicolous, solitary or compound, sessile, dimidiate or occasionally effused-reflexed; pileus convex above, occasionally imbricate or laterally connate, soft spongy and watery when fresh drying to tough or corky, anise-scented when fresh, up to 10 x 16 x 4 cm; surface velutinous, to villose-tomentose or glabrous, azonate or occasionally slightly radially rugose, mat, white or greyish to isabelline or drying yellowish; margin obtuse, entire, somewhat involute and concolorous with upper surface; pore surface white at first then greyish-brownish or smoky, drying yellowish or dark smoky; pores entire, rounded occasionally angular or elongated, 1 — 3 per mm; dissepiments thick, even or somewhat dentate; tubes 0.3 — 1.5 cm long, sometimes stratified, concolorous with context or with dark regions around their mouths; context white or pale cream, 0.5 — 2 cm thick, tough-fibrous, concentrically zonate.

FIG. 24.— **Trametes suaveolens.** a - e. Structures from cultures: (a) nodose-septate hyphae from the advancing zone; (b) unbranched fibre hyphae; (c) fibre hyphae with tapering branches; (d) spear-shaped end of fibre hypha; (e) chlamydospores.
f - n. Structures from carpophores: (f) thin-walled, nodose-septate hypha; (g) unbranched fibre hypha; (h) fibre hyphae with one to three branches toward the tip; (k) fibre hyphae with numerous short, tortuous branches; (m) sub-solid, nodose-septate hypha with numerous short, tortuous branches; (n) basidia and basidiospores.

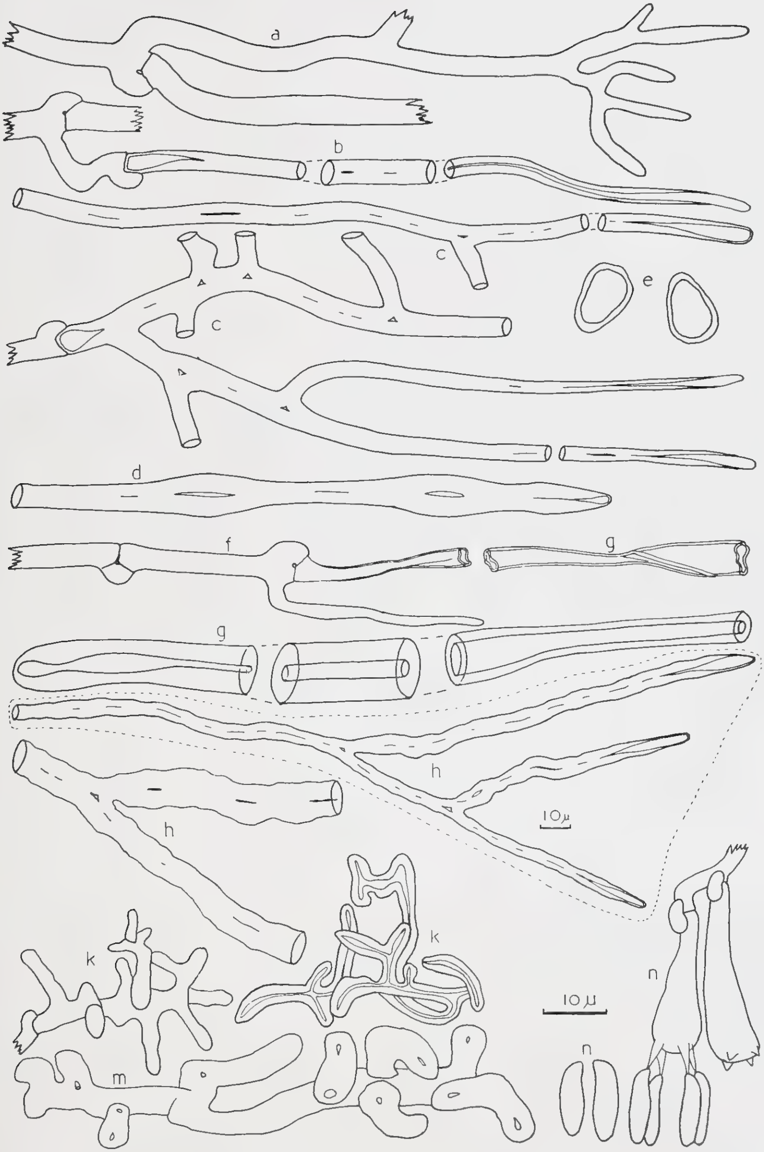

FIGURE 24.

Hyphal characters: (1) nodose-septate hyphae hyaline, branching, thin-walled, with deeply staining contents, 1.8 — 3.0μ in diameter (Fig. 24 f); (ii) fibre hyphae unbranched, long, more or less straight, hyaline, refractive, thick-walled, lumina narrow, aseptate often with staining contents, or reduced to a thin, interrupted line, but widening at the ends, 3.0 — 6.0μ in diameter (Fig. 24 g); (iii) fibre hyphae with one to three branches towards the tips, the branches long, tapering, irregularly beaded in outline, the walls thick, refractive, lumina reduced to an interrupted line, widening only at the tapering tips, 2.5 — 6μ in diameter (Fig. 24 h); (iv) fibre hyphae hyaline, repeatedly branched, the branches short, or very short, tortuous, lumina narrow or occluded, aseptate, 1.8 — 3.0μ in diameter, arising at clamped septa from lateral, thin-walled branches or thin-walled, nodose-septate hyphae (Fig. 24 k); (v) nodose-septate hyphae with numerous short, tortuous branches, thick-walled or solid with solid clamp connections, 3.0 — 4.0μ in diameter (Fig. 24 m).

Hymenium: basidia long clavate, hyaline 16.0 — 24.0 x 5.0 — 6.0μ bearing 4 thick sterigmata, 3.6 — 4.2μ long; basidiospores hyaline, long ellipsoidal to cylindrical, obliquely apiculate, thin-walled, smooth, 7.5 — 9.8 x 3.2 — 4.0μ (Fig. 24 n). *Construction.* The margin consists mainly of long, unbranched, hyaline, fibre hyphae mostly straight, arranged parallel to one another and intertwined to a small extent. Intertwined with the fibre hyphae are numerous thin-walled, branching, nodose-septate hyphae, from which the fibre hyphae arise. Behind the margin the fibre hyphae become sub-solid, or solid, and turn upward into the upper context or downward towards the pores. In the upper context the fibre hyphae are very loosely arranged, mostly parallel to each other with little intertwining, and with their thin-walled ends arranged at a common level and free to form the velutinous upper surface, or, agglutinated into tufts by brownish, resin-like material to form the villose-tomentose upper surface. Intertwined with the unbranched fibre hyphae are thin-walled, nodose-septate hyphae in small numbers as well as small numbers of fibre hyphae with irregularly beaded walls and two or three branches (Fig. 23 c, 24 h) the branches running diagonally across the unbranched fibre hyphae and interwoven with them. In the upper part of the context, aseptate fibre hyphae with numerous tortuous branches, (Fig. 24 k) intertwined with the other hyphae, are present in small numbers. In the lower context the tissues become much more dense and more compact. Small numbers of long, unbranched, fibre hyphae, turn downwards into the trama of the dissepiments; fibre hyphae with somewhat beaded walls and branches towards their ends, become more numerous, and their branches are extensively intertwined. Fibre hyphae with many short, contorted, sub-solid or solid branches (Fig. 23 d), intertwined with the other hyphae, and binding them into a compact tissue, are present in large numbers. Thin-walled, nodose-septate hyphae with deeply staining contents and branching frequently are intertwined and interwoven with the fibre hyphae. In the dissepiments, fibre hyphae with fairly long branches, tortuous and intertwined, and binding hyphae with numerous, short, tortuous branches, interwoven with the fibre hyphae and binding them across their direction of growth, constitute the bulk of the dense tissue. Thin-walled, nodose-septate hyphae, intertwined with the fibre hyphae, branch repeatedly and turn outwards towards the hymenial surfaces where their numerous, short, intertwined branches form a sub-hymenial layer of small isodiametrical cells about 5μ thick. From this layer the basidia are produced in a dense even stand. No accessory structures are present in the hymenium.

Decay and hosts

Trametes suaveolens causes a white, mottled rot of the heartwood of *Salix* spp. but is found occasionally on *Populus* and *Betula* spp.

Specimens examined

Herb. DAOM: F50, on *Salix* sp., Ottawa, Ont., Oct. 1929; F911, on *Salix* sp., Gaspé, Que., Sept. 1927; F948, on *Salix* sp., Ottawa, Ont., Sept. 1928; F994, on *Salix* sp., Ottawa, Ont., July 1929; F1297, on *Salix nigra,* Syracuse, N.Y., Nov. 1929; F1393, on *Salix* sp., Ottawa, Ont., Sept. 1930; F1633, on *Salix* sp., Woodpecker, B.C., Sept. 1927; F1954, Syracuse, N.Y., Aug. 1931; *F1964, on *Salix* sp., Hopewell, N.J., Sept. 1931; F2249, on living *Salix* sp., Winnipeg, Man., Apr. 1932; F2919, on living *Populus balsamifera,* Edmonton, Alta., Oct. 1932; F2994, on *Salix,* Greenwich, N.S., Sept. 1930; F3500, on *Salix* sp., Ottawa, Ont., Sept. 1933; *F3523, on *Salix* sp., Ottawa, Ont., Sept. 1933; F3669, on *Alnus incana,* Ste. Philomiene, P.Q., Apr. 1931; F3704, on dead *Populus balsamifera,* Edmonton, Alta., Nov. 1933; F5031, on *Salix* sp., Ottawa, Ont., Sept. 1934; F5032, on *Salix* sp., Ottawa, Ont., Sept. 1934; F5641, on *Salix* sp., Nov. 1941; *7654, on *Salix* sp., Matapedia, Que., Aug. 1937; F8043, on *Salix* sp., Ottawa, Ont., Oct. 1937; F8331, on living *Salix* sp., Matapedia, Que., Aug. 1938; 10812, on *Salix* sp., Kentville, N.S., Nov. 1941, 21570, on *Populus trichocarpa,* Quesnel, B.C., 1948; 30803, on living *Salix alba,* Leighton Buzzard, Gt. Brit., Jan. 1953; 31500, on *Salix* sp., Fredericton, N.B., Nov. 1954.

Herb. PRE: 21920, on *Salix alba,* Krieger, Schädliche Pilze, Apr. 1904; 10731, on *Populus trichocarpa,* Priest River, Idaho, July 1913.

Discussion

The description of the cultural characters, agrees well with those of Hirt (1932) and Nobles (1948). The cultures agree with those of other species in this group in many ways, but the fibre hyphae with short, tortuous branches or nodose-septate hyphae with solid, branching processes formed in some other species of this group as described below, were not present in cultures of *Trametes suaveolens.* The absence of these kinds of hyphae together with the soft, cottony-woolly texture of the mycelial mat and the fragrant, anise-like odour given off may serve to distinguish cultures of this species from the others with otherwise similar characters in this group.

The fruit-bodies of *Trametes suaveolens* are rather unusual in that their soft spongy feel belie their complex construction. From the descriptions it is clear that five kinds of hyphae could be distinguished in the carpophores. Besides thin-walled, nodose-septate hyphae or generative hyphae (Corner, 1932 a) two kinds of fibre hyphae of the skeletal system (Corner, 1932 a) are present while the binding system (Corner, 1932 a) consists of fibre hyphae with short tortuous branches and solid, nodose-septate hyphae with solid clamps and tortuous branches. These "binding hyphae" are very numerous only in the lower context above and among the tubes. Towards the upper context their numbers decrease rapidly so that their binding action is less pronounced and the upper context attains the soft texture so characteristic of the type species of *Trametes* Fr.

Bourdot & Galzin (1928) and Overholts (1953) reported that the hyphae of the carpophore of *Trametes suaveolens* are sparingly branched and thick-walled. Pinto-Lopes (1952) reported that the primary hyphae are thin-walled and nodose-septate while the secondary hyphae are thick-walled and aseptate. Donk (1933) described three types of hyphae from the carpophores of *Trametes suaveolens.* Teston (1953 b) after studies of species of Polyporaceae in the Bourdot herbarium in the Museum of Natural History in Paris, reported that the carpophores of *Trametes suaveolens* have a trimitic hyphal system, according to Corner's (1932 a) concepts, with branching, thin-walled, nodose-septate, generative hyphae and thick-walled or solid, branching, skeletal hyphae, staining in Giemsa, present in the context. In the tubes, extremely contorted, branching, binding hyphae, not staining with Giemsa, were present as well. The distribution of hyphae according to Teston (1953 a) however gives the impression that the context is dimitic, consisting of generative hyphae and branching and unbranched skeletal hyphae only whilst

the trama is trimitic with binding hyphae present as well. This trimitic hyphal system was later also reported by Kotlaba & Pouzar (1957) and O. Fidalgo (1957). These descriptions agree quite well with that given above, but do not distinguish clearly between the different kinds of hyphae in the different hyphal systems. As in the fruit-bodies of species of *Ganoderma* Karst. (Hansen, 1958), the fibre hyphae with branches towards the distal end contribute to the binding hyphal system in carpophores of *Trametes suaveolens*. The solid or thick-walled, nodose-septate hyphae, considered by Corner (1932 a) and Cunningham (1946, 1954) to be generative hyphae, similarly contribute to the binding system. In the fruit-body of *Trametes suaveolens* which has a trimitic hyphal system sensu Corner (1932 b), morphologically and ontogenically different hyphae thus contribute to the different hyphal systems. In this respect the fruit-bodies of *Trametes suaveolens* (L. ex Fr.) Fr. are similar to those of *Polyporus versicolor* L. ex Fr.

Comparison of the anatomy and hyphal characters of the fruit-bodies of *Trametes suaveolens* with those of *Polyporus versicolor*, shows great similarity in hyphal characters but a great difference in construction. Where the thin fruit-bodies of *Polyporus versicolor* abound with tortuous binding hyphae, the thick fruit-bodies of *Trametes suaveolens* have a poorly developed binding system with binding hyphae almost entirely absent from the upper context; but this difference appears to be one of degree of development of a particular hyphal system in a particular species and not a difference in the types of hyphae present which could indicate a phylogenetic difference in the carpophores of the two species. These two species thus appear to be related and in fact apparently represent two extremes of a series of species with similar hyphal, anatomical and micromorphological characters but varying in construction and texture. Other species described below, especially *Polyporus pubescens* Schum. ex Fr. and *Lenzites palisoti* (Fr.) Fr. appear to be intermediate between *Polyporus versicolor* and *Trametes suaveolens* in construction. This appears to be strong evidence in favour of the view held by Pilát (1936), and Kotlaba & Pouzar (1957) that the two species are congeneric; but it appears to be desirable that the hyphal characters and construction of the fruit-bodies of many more species in this complex of species be studied carefully before a final and satisfactory conclusion can be reached.

Comparison of the hyphal characters and carpophore construction of *Trametes suaveolens* (L. ex Fr.) Fr. with those of *Daedalea quercina* Fr. shows that the binding hyphae are not present in carpophores of the latter. The nodose-septate hyphae with irregularly thickened walls present in carpophores and cultures of *Daedalea quercina* are absent from those of *Trametes suaveolens*. This difference in the kinds of hyphae present in the carpophores indicates a phylogenetic difference between these two species so that *Daedalea quercina* and *Trametes suaveolens* cannot be regarded as being congeneric as suggested by O. Fidalgo (1957).

In *Trametes suaveolens* the structures formed in cultures are, with the exception of the chlamydospores, also present in the carpophores from which they were made. It is not unlikely that chlamydospores may be found in wood decayed by *Trametes suaveolens* as reported in other species by Cartwright & Findlay (1946).

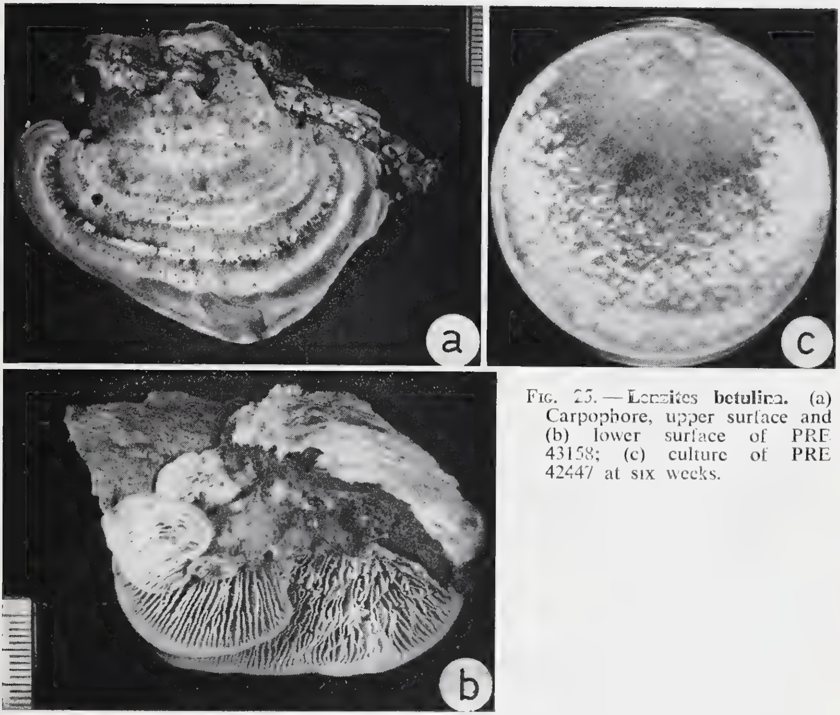

FIG. 25.—**Lenzites betulina.** (a) Carpophore, upper surface and (b) lower surface of PRE 43158; (c) culture of PRE 42447 at six weeks.

Lenzites betulina (L. ex Fr.) Fr., Epicr. Syst. Myc., 405, 1836 — 1838;
Daedalea betulina L. ex Fr., Syst. Myc. 1, 333, 1821;
Trametes betulina (L. ex Fr.) Pilát, Atl. Champ. Eur. III, 327, 1936.

Cultural characters

Growth is rapid to moderately rapid, the colony reaching a radiius of up to 30 mm in one week and covering the plate in 2 — 4 weeks. The margin is even, appressed, in some isolates over a narrow zone only, mycelium then raised, mostly cottony to woolly in a zone behind the advancing zone, then somewhat collapsed and more densely woolly with a pebble-like surface over the older part of the white mat. In time the mat gradually thickens developing raised areas of tough, felty or woolly-felty mycelium somewhat lacunose or developing a warty surface or rounded lumps of mycelium giving it a pebbly appearance, the intervening areas mostly thin appressed, sub-felty to felty. Mat very tough but separating easily from the agar. After about 4 weeks the pebbly mycelium may develop fruiting areas, at first warty, of pale "cream color" developing short, blunt, spines, rounded or somewhat flattened, glabrous or chamois. The reverse bleaches rapidly while a faint, pleasant, sweet, mushroomy odour is given off during the first two to four weeks. A strong positive reaction for extra-cellular oxidase results when alcoholic gum guaiac solution is applied to the mat.

Advancing mycelium: hyphae hyaline, thin-walled, nodose-septate, branching, often opposite the clamp connections, 2.0 — 6.0μ in diameter (Fig. 26 a).

Aerial mycelium: (a) nodose-septate hyphae hyaline, richly branched, narrow, 1.0 — 2.5μ in diameter (Fig. 26 b); (b) fibre hyphae long, straight, unbranched, hyaline, widest along the middle part, walls thickened and refractive, lumina narrow or reduced to a series of interrupted spaces, widening only towards the narrower, thin-walled ends, aseptate, 3.5 — 4.0μ in diameter at the widest parts (Fig. 26 c); (c) fibre hyphae with long tapering branches, hyaline, narrow, with prominent aseptate lumina with deeply staining contents, or lumina narrow or occluded, and hyphae solid, 1.5 — 3.0μ in diameter (Fig. 26 d); (d) nodose-septate hyphae with numerous short branches, walls thickened, lumina much reduced or hyphae solid, 1.5 — 3.0μ in diameter (Fig. 26 h).

Submerged mycelium: (a) nodose-septate hyphae as in the advancing zone.

Carpophore characters

Carpophore annual or perennial, lignicolous, solitary, sessile to effused-reflexed; pileus dimidiate, occasionally imbricate to laterally connate, coriaceous, up to 6.0 x 9.0 x 1.0 cm; surface tomentose or hirsute, concentrically zonate often multi-coloured, whitish or pale greenish grey or greyish brown; margin acute, entire, concolourous with upper surface, or lighter; pore surface white to "cream color" darkening somewhat on drying, usually lamellate, lamellae frequently branched or anastomising, occasionally poroid or labyrinthiform, about 1 mm apart, edges even or interrupted, decurrent behind; context white 0.5 — 3.0 mm thick, fibrous. *Hyphal characters:* (i) nodose-septate hyphae hyaline, branched, thin-walled, with conspicuous clamps, 1.2 — 3.0μ in diameter (Fig. 26 e); (ii) fibre hyphae long, more or less straight, unbranched or with an occasional short branch near the distal end, widest along the middle portion, thick-walled, refractive, lumina aseptate, narrow or reduced to an interrupted line, or hyphae solid except near the ends, 3.0 — 7.5μ in diameter (Fig. 26 f); (iii) fibre hyphae with numerous, short, tortuous branches, walls thickened, lumina narrow or occluded, aseptate 1.0 — 3.0μ in diameter (Fig. 26 g); (iv) nodose-septate hyphae with numerous flexuous branches, solid, occasionally sub-solid, 1.0 — 3.0μ in diameter (Fig. 26 h).

Hymenium: basidia hyaline, narrowly clavate, small, 20.0 — 26.0 x 4.0 — 5.0μ, with four, short, curved sterigmata, 2.5 — 3.0μ long (Fig. 26 k); basidiospores hyaline, cylindrical to slightly curved, smooth, thin-walled, with a small, oblique apiculus, 4.5 — 6.0 x 2.0 — 2.5μ (Fig. 26 m); tramal cystidia projecting 6.0 — 20.0μ above the hymenium, upper part broadly subulate, thick-walled, hyaline, lumina prominent, aseptate, mostly with brownish contents, and arising as lateral branches of fibre hyphae or directly from thin-walled, nodose-septate hyphae in the trama (Fig. 26 n).

Construction. At the margin the carpophore consists of long unbranched fibre hyphae, mostly with prominent lumina, more or less parallel in arrangement and

FIG. 26.— **Lenzites betulina.** a - d. Structures from cultures: (a) nodose-septate hyphae from advancing zone; (b) narrow, branched, nodose-septate hyphae from aerial mycelium; (c) unbranched fibre hyphae; (d) fibre hyphae with long, tapering branches.
e - n. Structures from carpophores: (e) thin-walled, nodose-septate hyphae; (f) unbranched, fibre hyphae; (g) fibre hyphae with numerous tortuous branches; (h) sub-solid or solid nodose-septate hyphae with numerous flexuous branches also found in cultures; (k) basidia; (m) basidiospores; (n) tramal cystidium with dark-coloured contents in sagittate terminal part.

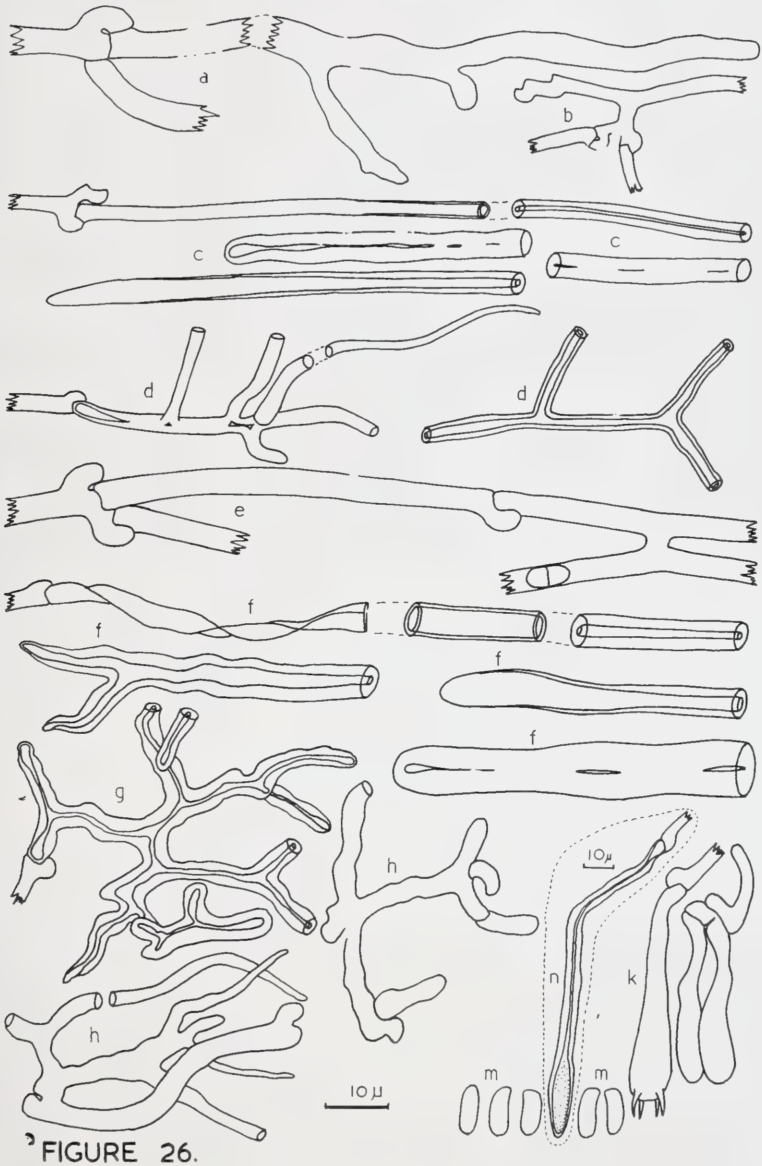

FIGURE 26.

interwoven with the numerous branching, thin-walled, nodose-septate hyphae from which they arise. In the context behind the margin the fibre hyphae are sub-solid and fibre hyphae with numerous, flexuous, lateral branches (binding hyphae) appear, with their branches interwoven with the unbranched hyphae across the direction of growth. The context consists mainly of long, unbranched, hyaline fibre hyphae, parallel to each other, slightly intertwined and small numbers of binding hyphae, tightly interwoven with the long fibre hyphae. In the upper context the long fibre hyphae turn upwards and the numbers of binding hyphae increase rapidly and thin-walled, nodose-septate hyphae, interwoven with the other hyphae, appear. This merges into a dense layer 100 — 200μ thick, at the upper surface which consists of numerous, branching, thin-walled, nodose-septate hyphae and binding hyphae all tightly interwoven with the long unbranched fibre hyphae which project beyond this layer to form the tomentose upper surface of the pileus (Fig. 26 f). These "hairs" of the upper surface may be sub-solid or solid, hyaline, or may have wide, aseptate, prominent lumina occasionally with brownish contents, and may be free or agglutinated into tufts. In the lower context the tissues are similar to the upper context but the numbers of binding hyphae increase rapidly towards the dissepiments and bind the straight fibre hyphae and thin-walled, nodose-septate hyphae into a dense, tough tissue from which individual elements can be dissected out only with difficulty. Many of these binding hyphae have solid or sub-solid clamps and appear to develop as a result of thickeneing of the walls of branched, nodose-septate hyphae (Fig. 26 h). Into the trama of the dissepiments, fibre hyphae from the lower context turn downwards where many may have one or more short, lateral branches near their tips (Fig. 26 f). The dissepiments consist mainly of binding hyphae with solid or sub-solid, aseptate, tortuous branches and nodose-septate hyphae with short, flexuous, sub-solid or solid branches, tightly interwoven with the unbranched fibre hyphae and branching, thin-walled, nodose-septate hyphae in a dense, tough tissue. In the dissepiments the thin-walled, nodose-septate hyphae branch frequently and turn towards the hymenial surfaces of the pores where the basidia are borne on their numerous, short, terminal branches. From the tramal tissues the ends of short, unbranched, fibre hyphae or lateral branches of fibre hyphae, project into and beyond the hymenium as tramal cystidia (Fig. 26 n).

Decay and hosts

Lenzites betulina causes a white rot of hardwoods.

Specimens examined

Herb. DAOM: F5115, on *Betula occidentalis,* Aleza Lake, B.C., July 1934; F5121, on *Betula* sp., Frankfurt am Main, Germany, Oct. 1934; F5229, on *Alnus incana,* Edmonton, Alta., Sept. 1931; F7205, on *Quercus* stump, Halifax, N.S., Jan. 1937; F7375, on *Populus tremuloides,* Oslo, Norway, Apr. 1937; F7462, on *Betula* sp. Ottawa, Ont., Aug. 1937; F8021, on *Fagus grandifolia,* Iberville, Que., Sept. 1938; F9071, on *Quercus acutissima,* Tokyo Science Museum No. 200645; F9156, Trinity Valley, B.C., Oct. 1938; F9909, on *Acer saccharum,* Petawawa, Ont., Sept. 1937; F9934, on *Acer saccharum,* Petawawa, Ont., Sept. 1939; *F10199, on *Betula* sp., dead branch, Montreal Is., Que., Aug. 1941; F10609, on *Betula* sp. dead branch, Montreal Is., Que., Aug. 1941; 10713, on *Betula* sp., Petawawa, Ont., Aug. 1941; 22291, on *Betula* sp. Quesnel, B.C., Aug. 1949; 22362, on *Eucalyptus* sp., Portugal, Herb. T. Pinto-Lopes No. 983; 22936, ex Herb. Hort. Bot. Reg., Kew; 30501, on *Betula papyrifera* pole, Parry Sound, Ont., Sept. 1951; 30504, *Acer rubrum* log, Horseshoe Lake, Ont., Aug. 1951; 30879, on *Acer rubrum,* Lake Rossignol, N.S., Sept. 1953; 30963, on *Betula pubescens,* Viljo Kujala, Fungi Fennici 663; 43109, Ithaca, N.Y., April 1953; 46598, on *Lithocarpus densiflorus,* Darlingtonia, Calif., Feb. 1944; 62359, on *Betula papyrifera,* Stone Creek, B.C., Aug. 1956; 52399, decaying trunk, Rio de Janeiro, Brazil, Sept. 1955; 53772, on *Betula* sp. stump, Flitwick, England, Oct. 1959; 69205, on *Betula papyrifera,* Naney, B.C., Aug. 1960; 69960, on *Betula papyrifera,* Dawson, Yukon, Terr. July 1959.

Herb. PRE: 2339, Knysna, C.P., June 1912; 3869, Rabenhorst-Winter, Fungi Europi No. 3529; 6616, on *Eucalyptus diversicolor,* Fort Cunynghame, C.P., May 1913; 13875, Herb.

J. R. Weir No. 654; 14833, Kirstenbosch, C.P., June 1921; 15485, on dead wood, George C.P., May 1922; 15576, on *Acacia mollisima,* Schwarzwald, Natal, May 1915; 17802, on *Podocarpus* sp., Knysna, C.P., May 1923; 20465, on *Podocarpus* sp., Knysna, C.P., Jan. 1925; 23478, on *Podocarpus* sp., Mount-aux-Sources, Natal, July 1928; 27277, on *Podocarpus* sp., Newlands, C.P., Aug. 1933; 27716, on *Podocarpus* sp., Donnybrook, Natal, Jan. 1935; 27967, Fungi Columbiani, E. Batholomeas No. 4935; 28604, on dead wood, Mooirivier, Natal, April 1936; 28878, on dead wood, Drakensberg, Natal, July 1937; 30189, on dead wood, Nkandhla Forest, Natal, March 1935; 30696, on dead wood, Deepwalls, Knysna, C.P., Apr. 1939; 31306, on *Quercus* sp., Kirstenbosch, C.P., Apr. 1939; 31333, on *Quercus* sp., Knysna, C.P., Apr. 1939; 31535, on living *Celtis kraussiana,* C.P., June 1921; 31558, on *Celtis kraussiana,* Katberg, C.P., Aug. 1915; 31879, *Eucalyptus* sp. logs, Knysna, C.P., Apr. 1917; 34926, on *Eucalyptus* sp., Melrose, Johannesburg, Apr. 1945; 34994, on *Acacia mearnsii* logs, Qudeni Forest, Natal, March 1935; 37481, on *Quercus* sp., Mycotheca generalis, Petrak, No. 574; 41526, on dead wood, Knysna, C.P., May 1956; 41527, on dead wood, Hogsback, C.P., May 1956; *42339, on dead wood, Dorset, Ont., Sept. 1962; *42363, on *Betula* sp., Dorset, Ont., Sept. 1962; *42434, on dead wood, Barberton, Tvl., June 1959; *42447, on *Acacia mearnsii* stumps, Kaapse Hoop, Tvl., Feb. 1961; 43158, on dead wood, George, C.P., March 1966.

Herb. STE: 352; 353, Eastern Cape Province; 422, Karkloof, Jan. 1922; 478, oak stump, Stellenbosch, Aug. 1921; 2156, oak stump, Kirstenbosch, L. Bolus, July 1925; 2810, ou hout, Stellenbosch, A. J. le Roux, Oct. 1944; 43, ou hout, (as *Lenzites guineensis* Fr.); 474, old logs, Stellenbosch, Oct. 1921; 488, ou hout, J. P. Leslie, ('n vorm van *L. betulina); 2212, L. aspera,* on dead *Olea laurifolia,* Knysna, J. F. V. Phillips, Dec. 1923.

Discussion

The description of cultural characters of *Lenzites betulina* agrees well with earlier descriptions by Davidson, Campbell & Blaisdell (1938), Cartwright & Findlay (1946) and Nobles (1948, 1965). This species resembles *Trametes suaveolens* and *Polyporus versicolor* in cultural characters and the structures produced in culture. The characteristic pebble-like mounds of mycelium forming on top of the very tough mat, may serve to distinguish cultures of this species from other closely similar species in Group 45.

From the descriptions it is evident that four kinds of hyphae are present in the carpophores of *Lenzites betulina.* The fifth kind, the long fibre hyphae with branches near the tip (arboriform hyphae, Teixeira, 1962 b) which are present in carpophores of *Polyporus versicolor* and *Trametes suaveolens* are absent from those of *Lenzites betulina.* Although short branches were seen on some fibre hyphae, these branches were so short as to be almost inconspicuous and not comparable to those in the carpophores of *Trametes suaveolens* and *Polyporus versicolor* so that these hyphae do not merit special designation. In carpophores of *Lenzites betulina,* the binding hyphal system also consists of branched, aseptate fibre hyphae and branched, thick-walled, nodose-septate hyphae which are morphologically and ontogenically distinct as in the carpophores of *Polyporus versicolor* and *Trametes suaveolens;* but since nodose-septate hyphae are regarded as generative hyphae by Corner (1932 a, b), Cunningham (1946, 1954) and Teixeira (1962 b) the carpophores of *Lenzites betulina* must possess a trimitic hyphal system as reported by Cunningham (1948 h), Teston (1953 b), Kotlaba & Pouzar (1957) and Fidalgo (1957). None of these authors however reported the nodose-septate, thick-walled binding hyphae.

From the above it is clear that the structures formed in cultures are also present in the carpophores from which they were made. The branched fibre hyphae or binding hyphae in cultures were less sinuous than those from the carpophores but as these hyphae are interwoven with the unbranched fibre hyphae in both the cultures and also in the carpophores, they must be regarded as homologous structures.

Comparison of the hyphal characters and construction of *Lenzites betulina* (L. ex Fr.) Fr. with those of the "brown species of *Lenzites*" (Overholts, 1953)

now generally referred to *Gloeophyllum* Karst., and desscribed in Group 13, reveals important differences. Apart from the yellowish-brown pigment in the walls of the fibre hyphae of these brown species, aseptate binding hyphae, which are so numerous in the carpophores of *Lenzites betulina,* are completely absent from those of *Lenzites trabea* Pers. ex Fr. In the trama of *Lenzites sepiaria* (Wulff. ex Fr.) Fr. the aseptate binding hyphae are present in the older parts of the context and have pale umber-brown walls and longer, less tortuous branches than those of *Lenzites betulina.* In cultural characters *Lenzites betulina* also differs markedly in respect of its white mat, hyaline hyphae and positive oxidase reaction from cultures of *Lenzites trabea* and *Lenzites sepiaria* with their brown coloured mats, pale brown fibre hyphae and negative reaction when tested for extra-cellular oxidase. *Lenzites betulina* therefore cannot be regarded as congeneric with the two brown species, *Lenzites sepiaria* and *Lenzites trabea*

In a discussion of the nomenclatural status of the genus *Daedalea* Pers. ex Fr. and related genera, Fidalgo (1957) concluded that no real distinction could be found between the genera *Daedalea* Pers. ex Fr., *Lenzites* Fr. and *Trametes* Fr. other than in hymenial configuration as expounded by Fries (1838). He named *Lenzites palisoti* (Fr.) Fr. as an example in which these three types of hymenial surfaces may often be seen combined in one fruit-body thus illustrating the artificiality of even this distinction. He therefore regarded the genera *Lenzites* Fr. and *Trametes* Fr. as synonymous with *Daedalea* Pers. ex Fr., the oldest genus. A comparison of the descriptions of the type species of the genera *Lenzites, Trametes* and *Daedalea* given above, shows that the nodose-septate hyphae with irregularly thickened walls which are found in cultures and carpophores of *Daedalea quercina* L. ex Fr., the type of the genus *Daedalea* (Donk, 1960), are absent from the cultures and carpophores of *Lenzites betulina* (L. ex Fr.) Fr. and *Trametes suaveolens* Fr., the type species of the genus *Lenzites* Fr. and *Trametes* Fr. respectively (Donk, 1960). Furthermore, the binding hyphae which are characteristic of the carpophores of *Lenzites betulina* and *Trametes suaveolens* are absent from those of *Daedalea quercina.* The carpophores of *Daedalea quercina* thus have dimitic hyphal systems, in the sense of Corner (1932 a, b) while those of *Lenzites betulina* and *Trametes suaveolens* have trimitic hyphal systems. There are thus distinct and fundamental differences in the hyphal systems and construction of the carpophores of the type species of the genus *Daedalea* Pers. ex Fr. on the one hand and the genera *Lenzites* Fr. and *Trametes* Fr. on the other. Therefore, the latter two genera cannot possibly be regarded as being congeneric with *Daedalea quercina* despite similarities in gross morphological characters.

From the above descriptions it is evident that cultural characters, hyphal characters and the construction of the carpophores of *Polyporus versicolor, Trametes suaveolens* and *Lenzites betulina* are very similar in many respects. This similarity caused Donk (1933) to express the view that the genera *Coriolus* Quél., *Trametes* Fr. and *Lenzites* Fr., of which these three species are the respective types, (Cooke, 1959) may be congeneric. This was also the basis for Pilát's (1936) inclusion of the genera *Coriolus* Quél. and *Lenzites* Fr. in *Trametes* Fr. A careful comparison of the hyphal characters of the three species shows that the fibre hyphae with one or two long branches near their ends are absent from the carpophores of *Lenzites betulina* but are present in those of *Polyporus versicolor* and *Trametes suaveolens.* In carpophores of *Trametes suaveolens,* fewer binding hyphae are present than in those of the other two species. Carpophores of *Trametes suaveolens* thus differ from those of the other two species in the numbers of one kind of hypha present while carpophores of *Lenzites betulina* differ from those of *Polyporus versicolor* and *Trametes suaveolens* in the kinds of hyphae present. Since the kinds of hyphae present in carpophores are considered to be important at the

generic level (Bondartzeva, 1961; Teixeira, 1962 b), it appears that *Lenzites betulina* cannot be considered to be congeneric with *Polyporus versicolor* and *Trametes suaveolens*. The importance of the absence of these hyphae from carpophores of *Lenzites betulina* can however be confirmed only by examination of a large number of specimens and many different species with similar anatomical and micromorphological characters; but from the above descriptions and descriptions of the following species in this group, it appears as if this character, if considered in combination with the presence of a predominantly lamellate hymenium, may be the characters which distinguish the genus *Lenzites* Fr. from the closely related genus *Trametes* Fr.

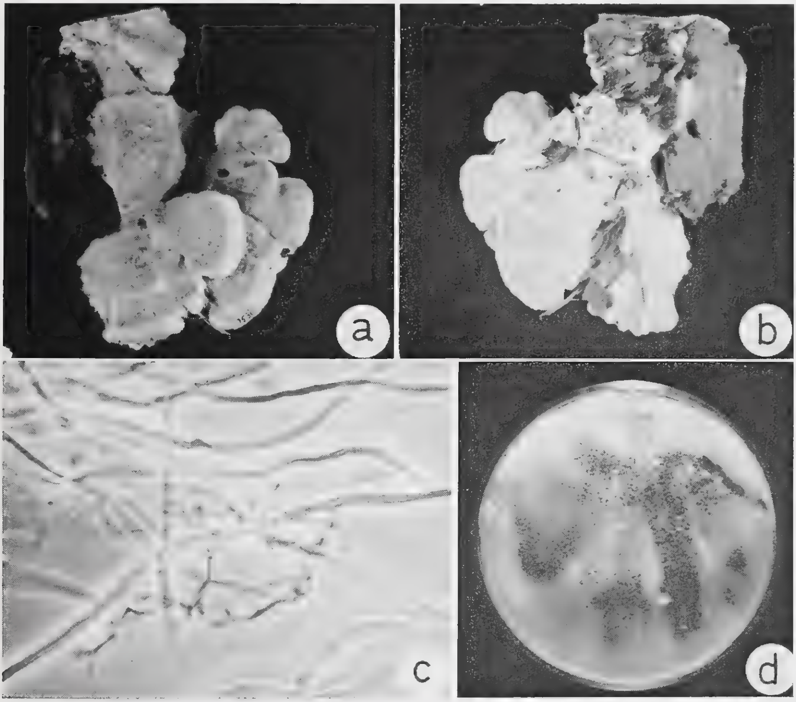

Fig. 27.— **Polyporus pubescens.** (a) Carpophores of DAOM 17530, upper surfaces and (b) hymenial surfaces; (c) narrow, dichotomously branched hyphae and unbranched fibre hyphae from culture, × 500; (d) culture of DAOM 17577 at six weeks.

Polyporus pubescens *Schum. ex Fries,* Syst. Myc. 1, 367, 1821;

Coriolus pubescens (Schum. ex Fr.) Quélet, Fl. Myc. Fr. p. 391, 1881;

Trametes pubescens (Schum. ex Fr.) Pilát, Atl. Champ. Eur. III, 268, 1939.

Cultural characters

Growth is moderately rapid, the mat reaching a radius of up to 35 mm after 1 week and covering the plate after 2 to 3 weeks. Margin even, raised, white, cottony to woolly; mat raised behind margin, becoming appressed, compact, woolly.

towards inoculum. Farinaceous areas appear and increase in size resulting in a finely pebbled appearance of the surface; or, mat felty with thin, pellicular areas appearing, which increase in size and coalesce to form irregular, pellicular areas occasionally involving the entire mat, the surface irregularly, radially grooved, or, smooth between the grooves, or, roughly lacunose with small raised, anastomosing ridges and wart-like protruberances in the older parts of the pure, white mat. Pale "cream color" irregular, raised, spongy areas may appear along the side of the dish, with similar warted surfaces, giving rise to minute, acicular spines, bearing basidia and basidiospores. The reverse bleaches after one to two weeks and a faint mushroomy odour is given off. A strong positive reaction for extra-cellular oxidase is given with gum guaiac solution. Strong diffusion zones are formed on gallic acid agar and tannic acid agar. No growth occurs on gallic acid agar but colonies up to 40 mm in diameter on tannic acid agar after one week.

Advancing mycelium: hyphae hyaline, branching, thin-walled, nodose-septate, 2.0 — 3.5μ in diameter and with deeply staining contents (Fig. 28 a).

Aerial mycelium: (a) thin-walled, nodose-septate hyphae as in the advancing zone; (b) fibre hyphae hyaline, long, unbranched, walls thick, refractive, sub-solid to solid, up to 4.5μ in diameter (Fig. 28 b); (c) fibre hyphae hyaline, branched, the branches long, flexuous, tapering gradually towards the tips, the lumina prominent, aseptate, 2.0 — 3.0μ in diameter (Fig. 28 c); (d) hyaline, much branched, solid, refractive processes, arising from nodose-septate hyphae, 1.5 — 4.0μ in diameter (Fig. 28 d); (e) hyaline, very narrow, reticulately branching hyphae, solid, 0.5μ in diameter (Fig. 27 c).

Fructification: basidia long, clavate, 10.0 — 17.0 x 3.6 — 4.5μ, with 4 straight sterigmata, 3.0 — 3.6μ long (Fig. 28 h); basidiospores hyaline, cylindrical, straight or slightly curved, apiculate, smooth, thin-walled, 4.5 — 5.0 x 1.5 — 2.0μ (Fig. 28 h).

Submerged mycelium: (a) nodose-septate hyphae as in the advancing zone; (b) hyaline, branched, nodose-septate hyphae with slightly thickened walls, empty, 1.0 — 3.0μ in diameter with short, much-branched processes either with thickened walls or solid and refractive (Fig. 28 f); (c) chlamydospores hyaline, ovoid to irregularly ellipsoid or fusoid, 6 — 14 x 4.5 — 9.0μ (Fig. 28 g).

Carpophore characters

Carpophores annual, lignicolous, grouped or compound, sessile, or in circular clusters attached at the centre, often imbricate and laterally connate; pileus applanate to conchate or flabellate; coriaceous and somewhat watery when fresh, drying to rigid 1 — 5 x 2 — 6 x 0.3 — 1.0 cm; surface villose-tomentose to almost hirsute at base, to finely tomentose or glabrescent, often radially striate towards the margin, creamy white to "cartridge buff" or "tilleul buff"; margin obtuse, entire to lobate, creamy white; pore surface poroid, white, drying to "cream buff" or

FIG. 28.—**Polyporus pubescens.** a - h. Structures from cultures: (a) thin-walled, nodose-septate hyphae from advancing zone; (b) unbranched fibre hyphae; (c) branched fibre hyphae; (d) hyaline, much-branched solid processes arising from nodose-septate hyphae; (f) nodose-septate, thick-walled hyphae with solid, refractive, branched processes; (g) chlamydospores; (h) basidia and basidiospores.
k - s. Structures from carpophores: (k) thin-walled, nodose-septate hyphae; (m) unbranched fibre hypha; (n) fibre hypha with branches towards the distal end; (p) fibre hypha with short, tortuous branches; (q) solid, contorted, branched, nodose-septate hyphae; (s) basidia and basidiospores.

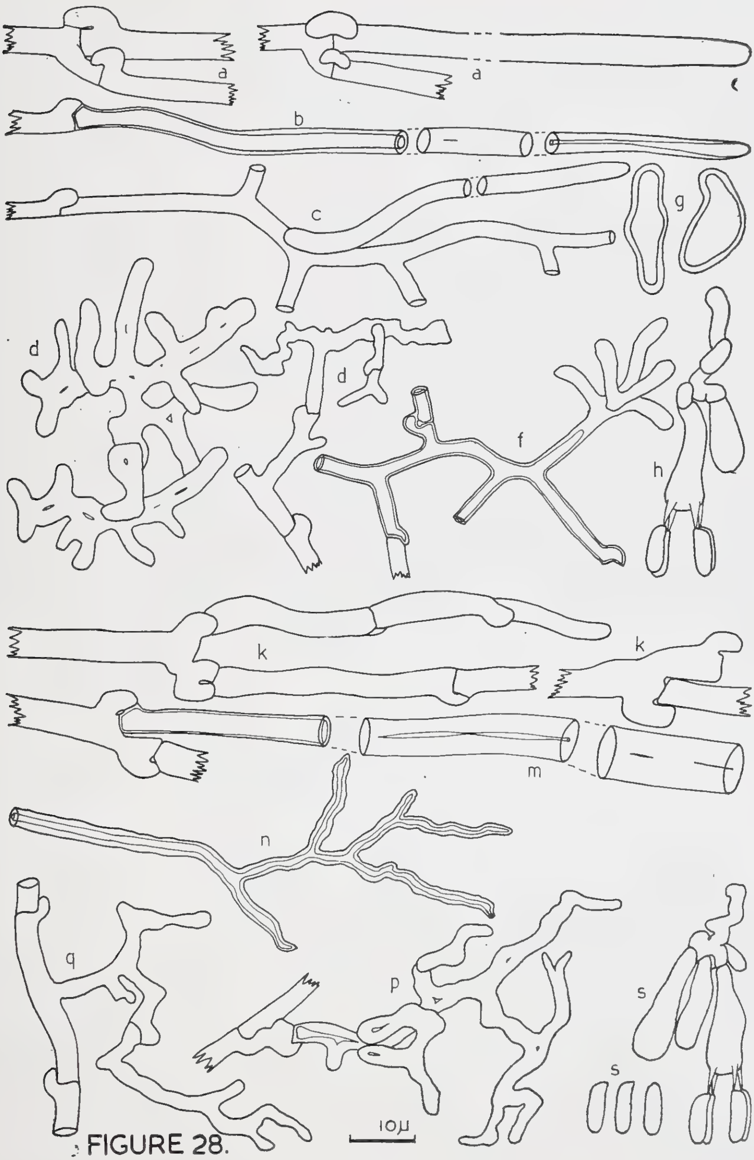

FIGURE 28.

"warm buff"; pores angular, 3 — 4 mm; dissepiments thick at first, 1 — 4 mm deep; context white, zonate and with fine radiating fibres, 1 — 6 mm thick.

Hyphal characters: (1) nodose-septate hyphae hyaline, branching at or between the septa, thin-walled, with deeply staining contents, 2.2 — 3.6μ in diameter (Fig. 28 k); (2) fibre hyphae long, unbranched, hyaline, walls somewhat thickened, lumina prominent, aseptate often collapsed towards the thin-walled extremities, 3.0 — 4.5μ in greatest diameter, or, walls much thickened, lumina very narrow, aseptate or occluded and hyphae sub-solid to solid with lumina visible at the extremities only, 4.0 — 6.0μ in diameter (Fig. 28 m); (3) fibre hyphae with thick hyaline walls and aseptate lumina, branching repeatedly over a short distance towards their tips the branches long, somewhat beaded in appearance and 3.5 — 6.0μ in diameter (Fig. 28 n); (4) contorted fibre hyphae with many short thick, solid branches, 3.0 — 6.0μ in diameter (Fig. 28 p); (5) thick-walled solid nodose-septate hyphae twisted and contorted and resembling (4) above but with solid clamps, 2.5 — 5.0μ in diameter (Fig. 28 q).

Hymenium: basidia clavate, 11.0 — 16.0 x 3.6 — 4.5μ, bearing four straight sterigmata, 3.0 — 3.5μ long; basidiospores hyaline, long cylindrical, occasionally somewhat curved, obliquely apiculate, smooth, thin-walled, 4.2 — 7.2 x 1.8 — 2.4μ (Fig. 28 s). Hyphal pegs broadly conical rising up to 50μ above level of hymenium.

Construction. At the margin the carpophore consists mainly of long, straight, unbranched fibre hyphae with relatively thick walls and tips often collapsed, the hyphae slightly interwoven and orientated parallel to the direction of growth of the pileus. Immediately behind the foremost marginal fibre hyphae and intertwined with other fibre hyphae, are numerous branching, thin-walled, nodose-septate hyphae from which the fibre hyphae arise. Intertwined and interwoven with these hyphae are the numerous short, contorted branches of thick-walled or solid, branched fibre hyphae which bind these other hyphal elements into a tough tissue. Behind the margin and towards the upper part of the context the fibre hyphae bend upwards towards the upper surface. In the upper context the unbranched fibre hyphae are orientated upwards and lightly intertwined. Interwoven with these hyphae are binding hyphae which are either short, tortuous branches of long fibre hyphae or short, much-branched, fibre hyphae with sub-solid or solid branches, or, thick-walled or solid much-branched, nodose-septate hyphae. These hyphae bind the tissues into a tough, homogeneous mass. Thin-walled, nodose-septate hyphae with deeply staining contents are numerous in the upper context especially just below the upper surface. The upper surface is acuticulate and consists of the ends of long fibre hyphae, mostly solid and projecting somewhat above the level of the tissues, bound together by the binding hyphae to form the tomentose upper surface of the younger part of the pileus. In the older parts nodose-septate hyphae with deeply staining contents grow upwards beyond this layer and become closely associated and agglutinated with the ends of fibre hyphae to form the hirsute to fibrillar trichoderm of the older parts of the context. In the lower context the long fibre hyphae turn downwards into the tramal tissues. Here the fibre hyphae with terminal branches become more numerous and the short, much-branched fibre hyphae with solid branches and thick-walled nodose-septate branched hyphae become very numerous to form a denser and tougher tissue than the upper context. All hyphae are more flexuous and narrower than in the upper context and are tightly interwoven to form the tramal tissues. Here, the thin-walled, nodose-septate hyphae with deeply staining contents are inextricably interwoven with the other hyphae, branching profusely, the branches short and emerging on the surfaces of the pores where they bear fasicles of basidia. On the pore surfaces are conical hyphal pegs consisting of small bundles of fibre hyphae of which the ends project beyond the hymenial surfaces.

Decay and hosts

Polyporus pubescens causes a white rot of hardwood logs (Nobles, 1948).

Specimens examined

Herb. DAOM: *17530, on *Quercus macrocarpa,* Carberry, Man., Sept. 1947; *17542, on *Betula papyrifera,* Blue Lake, Duck Mt. For. Res., Sept. 1947; 17561, on dead *B. papyrifera,* Buffalo Narrows, Sask., Sept. 1947; *17577, on *Fagus grandifolia* log, Chelsea, Que., Oct. 1947; *17578, on *Acer* sp., Gatineau Park, Que., Oct. 1947; *52833, on *Populus* sp., Belfast, New York, Oct. 1956; 53503, Pack Forest, Warrensburg, N.Y., Oct. 1959; *73309, on dead *Alnus* stump, Deux Rivieres, Ont., Sept. 1955; *94017, on dead *Acer* sp., Dorset, Ont., Sept. 1962; *94026, on dead *Acer* sp., Mouse Lake, Ont., Sept. 1962; *94039, on yellow birch, Dorset, Ont., Sept. 1962.

Interfertility studies

Nobles (1965) reported that this species has the tetrapolar type of interfertility. It was attempted to establish the conspecificity of some new collections of *Polyporus pubescens* with older collections by means of the "Buller phenomenon." For this purpose, two mycelia, each obtained from a single basidiospore of collection DAOM 94039, were used as the haploid mycelium. The dikaryotic mycelia of the collections to be examined were inoculated on the plates four days after the plates had been inoculated with the haploid mycelia. Two days later the mycelia from the two inocula met and after three more days the haploid mycelia were examined at their peripheries for clamp connections. None were found. After 7 more days' incubation the colonies were again examined and again after a further 7 days, i.e. up to 14 days after the mycelia met on the plates. No clamp connections were ever observed on these haploid mycelia. It is thus not possible to use the "Buller phenomenon" to test conspecificity among isolates of *Polyporus pubescens.* The cause for the failure of clamps to form on these mycelia, is not known but was not due to the disintegration of hyphae as a result of oidium formation by the haploid mycelium as found in *Merulius americanus* by Hwang (1955). A similar failure of dikaryotic mycelia to dikaryotise a haploid mycelium of the same species was reported by Nobles (1967) in *Basidioradulum radula* [(Fr.) Fr.] Nobles.

The collections examined in this way are listed in Table 5.

Discussion

The cultural characters as described above, agree well with those of other species in Group 45. In an earlier description Nobles (1948) described the fibre hyphae formed in cultures as having branches "ending in whiplash-like ends." This description, as well as a later one (Nobles, 1965) in which she mentioned the "network of narrow hyphae" formed in cultures, agree well with the above description. The mat formed by *Polyporus pubescens* in culture resembles those of *Polypores versicolor* and *Lenzites betulina* in many respects but may be distinguished from these two species by careful observation and comparison of all characters.

In the carpophore five kinds of hyphae could be distinguished. It was found that three types of hyphae, viz. nodose-septate hyphae with thickened walls, lateral branches of long fibre hyphae and fibre hyphae with numerous short, aseptate branches together constitute the hyphae of the binding system. These hyphae arise in different ways and are morphologically and ontogenically different; but since the thick-walled, nodose-septate hyphae are regarded as homologous with thin-walled, nodose-septate hyphae by Corner (1932 a), Cunningham (1946) and Teixeira (1962 b) and since branched fibre hyphae are regarded as hyphae of the skeletal system like unbranched fibre hyphae by Teixeira (1962 b), the carpophores of *Polyporus pubescens* have a trimitic hyphal system consisting of nodose-septate generative hyphae, skeletal hyphae and binding hyphae as reported by Teston (1953 b).

From the above description it is evident that the structures formed in cultures are also present in the carpophores from which they were made with the exception of the narrow, reticulately branching hyphae. These hyphae could not be located in the carpophores. The hyphae with solid, branched processes formed in culture, do not form pseudo-parenchymatous areas over the cultures in the manner of hyphae with interlocking projections found in cultures of Group 53. Instead, these processes are interwoven with fibre hyphae in the mat, which they bind into tough, felty parts which are teased out only with great difficulty. These hyphae thus appear to be binding hyphae which are also found in such large numbers in the carpophores, interwoven with long, unbranched, fibre hyphae.

Carpophores of *Polyporus pubescens* resemble those of *Polyporus versicolor* and *Trametes suaveolens* in hyphal characters and, to a lesser extent, in construction. The same types of hyphae present in the carpophores of *Polyporus pubescens* are also present in carpophores of the other two species but in apparently different numbers, so that the carpophores differ in construction and texture. Although carpophores of *Polyporus pubescens* have relatively fewer binding hyphae than those of *Polyporus versicolor*, especially in the middle context, and are consequently somewhat softer and less leathery, the binding hyphae are concentrated in the trama and at the upper surface. In this respect the carpophores of *Polyporus pubescens* differ somewhat in construction from those of *Polyporus versicolor;* but they differ even more from those of *Trametes suaveolens* in which binding hyphae are almost absent from the upper context. Therefore *Polyporus pubescens* seems to be more closely related to *Polyporus versicolor* than to *Trametes suaveolens* a fact recognized by Quélet (loc. cit.) when he included *Polyporus pubescens* in his new genus *Coriolus.*

Trametes meyenii *(Klotzsch) Lloyd*, Myc. Writ. 5, Lett. No. 67, 14, 1918;

Polyporus meyenii Klotzsch, Nova Acta Acad. Leop. — Carol. 19, Suppl. 236, 1843;

Polystictus meyenii Klotzsch in Fungi Orb. terv. circ. a Meyen. Coll. p. 236, 1843;

Coriolus meyenii (Klotzsch) G. H. Cunningham, Proc. Linn. Soc. N.S.W., 75, 214 — 249, 1950;

Cerrena meyenii (Klotzsch) Hansen, Na. Hist. Rennell Isl., Brit. Sol. Isl. 3, 129, 1960.

Cultural characters

Growth is rapid the mat reaching a radius of 60 — 70 mm in 7 days and covering the plate in 10 — 12 days. Advancing zone even, thin, appressed for 1 — 2 mm behind the margin, then raised, the young mycelium hyaline and evenly thin, woolly, the mat increasing in thickness towards the inoculum. The thickest parts develop faint tints of "cream color" after two weeks. Surface at first smooth, even or faintly, radially sulcate and remaining so with the mat gradually thickening to an extremely tough, sub-felty texture, or, later becoming roughened or irregularly lacunate or granular over the thickest part and around the inoculum. The mat remains white except over the thickest parts where colours gradually deepen to "light buff" or "pale ochraceous buff". Occasionally thin, short, erect, "light buff" spines, up to 1.0 mm in height and bearing basidia and basidiospores, develop in small depressions in lacunose areas over the thickest part. The reverse is bleached after 2 weeks and a faint, fragrant, mushroomy odour is given off up to the fourth week. On gallic acid and tannic acid media colonies of up to 40

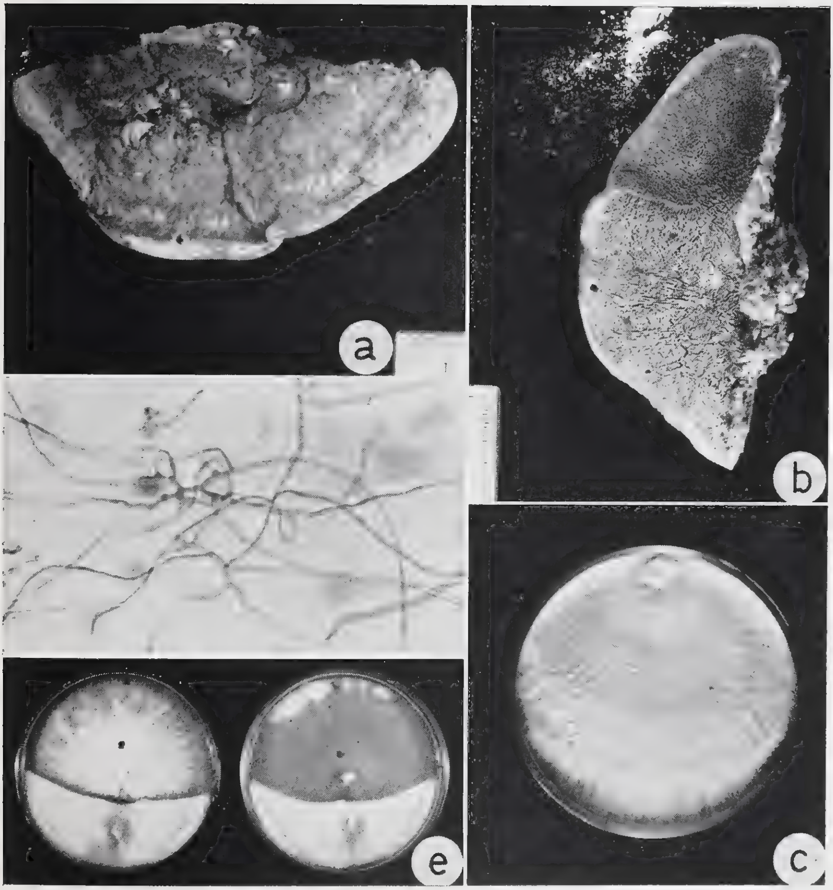

FIG. 29.—**Trametes meyenii.** (a) Carpophore of PRE 42446, upper surface and (b) hymenial surface; (c) culture of PRE 42446 at six weeks; (d) fibre hypha with numerous long, tapering branches from fruit-body, × 250; (e) "Buller phenomenon" plates of PRE 42459, bottom, diploid, with PRE 42446 — 14 and PRE 42446 — 16, top, haploid.

mm and 60 mm respectively and strong diffusion zones, are formed in seven days. A strong positive reaction results when cultures are tested for extra-cellular oxidase by means of gum guaiac solution.

Advancing mycelium: hyphae hyaline, thin-walled, with simple clamp connections at the septa, branching near the septa, 2.5 — 4.0μ in diameter (Fig. 30 a).

Aerial mycelium: (a) hyphae as in the advancing zone; (b) fibre hyphae hyaline, long, unbranched, narrow towards the ends, widening to up to 6μ in diameter near the middle part, walls thick, refractive, lumina aseptate, narrow or occluded, widening towards the ends (Fig. 30 b); (c) fibre hyphae narrow, 1.5 — 3.0μ in diameter branching repeatedly over a short distance of main stem, the branches sub-solid to solid, flexuous, tapering gradually towards the tips (Fig. 30 c); (d) oidia numerous in some isolates, hyaline, ovoid to cylindrical with rounded ends, 2.0 — 3.0 x 3.0 — 6.0μ (Fig. 30 d).

Fructifications: basidia short, broadly clavate, 10.0 — 15.0 x 4.5 — 6.0μ, with four slender, straight, sterigmata 3.0μ long (Fig. 30 e); basidiospores hyaline, smooth, ellipsoid-cylindrical to cylindrical with rounded ends, obliquely apiculate, thin-walled, 4.5 — 6.0 x 2.0 — 2.5μ (Fig. 30 f).

Submerged mycelium: (a) nodose-septate hyphae as in the advancing zone, often without contents and walls thickened; (b) oidia as in the aerial mycelium.

Carpophore characters

Carpophores annual or reviving a second season, lignicolous, solitary; pileus sessile, dimidiate, occasionally imbricate, to effused-reflexed, often concave above, woody or corky up to 30 x 12 x 6 cm; upper surface yellowish buff to brownish grey or grey, velvety to tomentose often glabrous with age or rimose, often tuberculate and concentrically sulcate, zonate or azonate, mostly with a hard, bay-brown layer under the tomentum in the older part; margin obtuse, rounded, entire or lobed, finely velvety, creamy white, drying yellowish; pore surface creamy white when fresh, drying to pale buff or creamy buff; pores usually elongate, sinuous to labyrinthiform 1 — 3/mm, dissepiments thin; tubes 0.5 — 2.0 mm deep, concolourous with surface, occasionally indistinctly stratified, becoming bleached in age. Context creamy white to pale creamy or buff, fibrous, zonate, 5.0 — 40.0 mm thick, often with a dark, hard zone under the tomentum in older part.

Hyphal characters: (1) thin-walled, nodose-septate hyphae with simple clamp connections, frequently branched, 2.0 — 3.0μ in diameter (Fig. 30 g); (2) fibre hyphae hyaline, long, unbranched, narrow, thin-walled, 1.5 — 2.0μ in diameter near their origin, widening to 6μ maximum diameter with narrow or occluded, aseptate lumina (Fig. 30 h); (3) fibre hyphae as above but with two or three branches towards the distal ends, branches long, tortuous and tapering towards the ends, 1.5 — 3.5μ in diameter (Fig. 30 k); (4) fibre hyphae unbranched as above but with short, barblike, lateral projections or branches towards the distal ends, 4.0 — 6.0μ in diameter (Fig. 30 m); (5) hyaline fibre hyphae usually solid, without clamp connections or septa, with numerous branches, the branches short and tortuous or long, flexuous and tapering towards their ends, 0.7 — 3.0 in diameter (Fig. 30 n); (6) nodose-septate hyphae with numerous short, tortuous, sub-solid to solid branches, 1.2 — 3.0μ in diameter (Fig. 30 p).

Hymenium: basidia short, broadly clavate, 10.0 — 15.0 x 4.5 — 6.0μ, with four sterigmata, 3.0μ long (Fig. 30 p); basidiospores hyaline, smooth, ellipsoid-cylindrical or short cylindrical with rounded ends, obliquely apiculate, thin-walled, 4.5 — 6.0 x 2.0 — 2.5μ (Fig. 30 q). Hyphal pegs small, conical, projecting up to 60μ beyond the hymenium.

Construction. The margin of the carpophore consists mainly of long unbranched fibre hyphae with narrow lumina and arranged parallel to one another. Intertwined with these are numerous thin-walled, nodose-septate, frequently branching hyphae, from which they arise. Behind the margin the fibre hyphae are mostly solid. Hyaline, solid or sub-solid, aseptate binding hyphae with their branches interwoven with the other hyphae, appear in the context tissue. The middle and upper context consist mainly of more or less parallel, intertwining fibre hyphae, unbranched or with one to three branches towards the tips, which turn upwards towards the upper surface. Intertwined with these are thin-walled, nodose-septate hyphae just below the upper surface, and numerous narrow, solid, branching fibre hyphae, binding the tissues together, in the middle part of the context. At the upper surface numerous branched fibre hyphae, mostly with the upper parts of their lumina fairly wide, project beyond the context tissues to form the hairy upper surface present in many specimens. In the older parts of the specimen, these fibre hyphae often become agglutinated by a hard, lacquer-like substance into a hard, rimose crust up to 1.5 mm thick. In the younger parts, the fibre hyphae project very little beyond the upper level of tissue composed of nodose-septate hyphae, fibre hyphae and binding hyphae to form the smooth, finely pubescent, upper surface. In the lower context and towards the tubes, the tissues become increasingly dense and consist of solid, unbranched, fibre hyphae and fibre hyphae with one to three long branches near their ends, often somewhat flexuous, and turning downwards towards the dissepiments. Intertwined with these are occasional fibre hyphae with short lateral projections. Numerous "binding hyphae", some with solid clamp connections, tightly interwoven with the other fibre hyphae, bind them into a tough, woody tissue. In the dissepiments the fibre hyphae are indistinguishable from each other, are very tortuous and tightly interwoven but orientated in a downward direction. Here they have slightly wider lumina and are narrower in diameter. Intertwined with the fibre hyphae are numerous, thin-walled, nodose-septate hyphae which branch profusely towards the surfaces of the dissepiments where they bear clusters of basidia on numerous, short, lateral branches. On the hymenial surfaces, conical hyphal pegs,consisting of bundles of parallel ends of fibre hyphae, project beyond the hymenium.

Decay and hosts

This fungus causes a white rot of hardwoods. It is common in subtropical regions where it grows on dead wood but is frequently found fruiting on the trunks of living *Acacia* species in South Africa.

Specimens examined

Herb. DAOM: 30792, on *Cassia siamea*, Njala, Sierra Leone, Aug. 1953; 69924, on *Cassia siamea* Rennell Island, Brit. Solomon Isl.. Oct. 1954.

Herb. PRE: 1873, on *Citrus sinensis*, Pretoria, Tvl., July 1911; 2114, on dead hardwood, Pretoria, Tvl., Feb. 1912; 5184, on *Acacia decurrens*, Ixopo, Natal, Sept. 1912; 6917, on *Acacia decumens*, Ixopo, Natal, July 1913; 8859, on *Acacia horrida*, Pretoria, Tvl., March 1915; 8877, on *Acacia horrida*, Pretoria, Tvl., March 1915; 9545, on dead *Celtis thamnifolia*, Ngadu Forest, C.P., Jan. 1916; 11437, in Fungi Malayana, Mt. Maquiling, Philippines, July 1916; 12183, on dead *Acacia* sp. stumps, Adelaide. C.P., May 1919; 13040, on stumps. Mulanga For., Uganda, July 1919; 13943, as *Daedalea hobbsii* v.d. Bijl, Howick, Natal; 14651, on dead tree, Pretoria, April 1921; 14840, on dead tree, Kirstenbosch, Cape Prov., June 1921; 14904, on dead tree, Entebbe, Uganda; 15569, on dead tree, Ginginhlovu, Natal, July 1915; 24874, on dead tree, Pretoria, March 1915; 26402, on dead tree, Pietermaritzburg, Natal, Aug. 1932; 27564, dead stump, Pretoria, Tvl., April 1934; 27705, dead stump, Donnybrook, Natal, Jan. 1935; 28563, as *Daedalea hobbsii*, Winters Kloof, Pietermaritzburg, Sept. 1934; 28875, on *Acacia* sp., Louis Trichardt, Tvl., Aug. 1937; 30267, on dead wood, Donnybrook, Natal, Feb. 1936; 30725, on dead wood, Rustenburg, Tvl., March 1939; 30804, on dead wood, Xumeni Forest, Natal, Dec. 1936; 31311, on dead wood, Knysna, C.P., Dec. 1936; 31543, on dead wood, Pretoria, Tvl., July 1915; 31548, on dead wood, Grahamstown, C.P.,

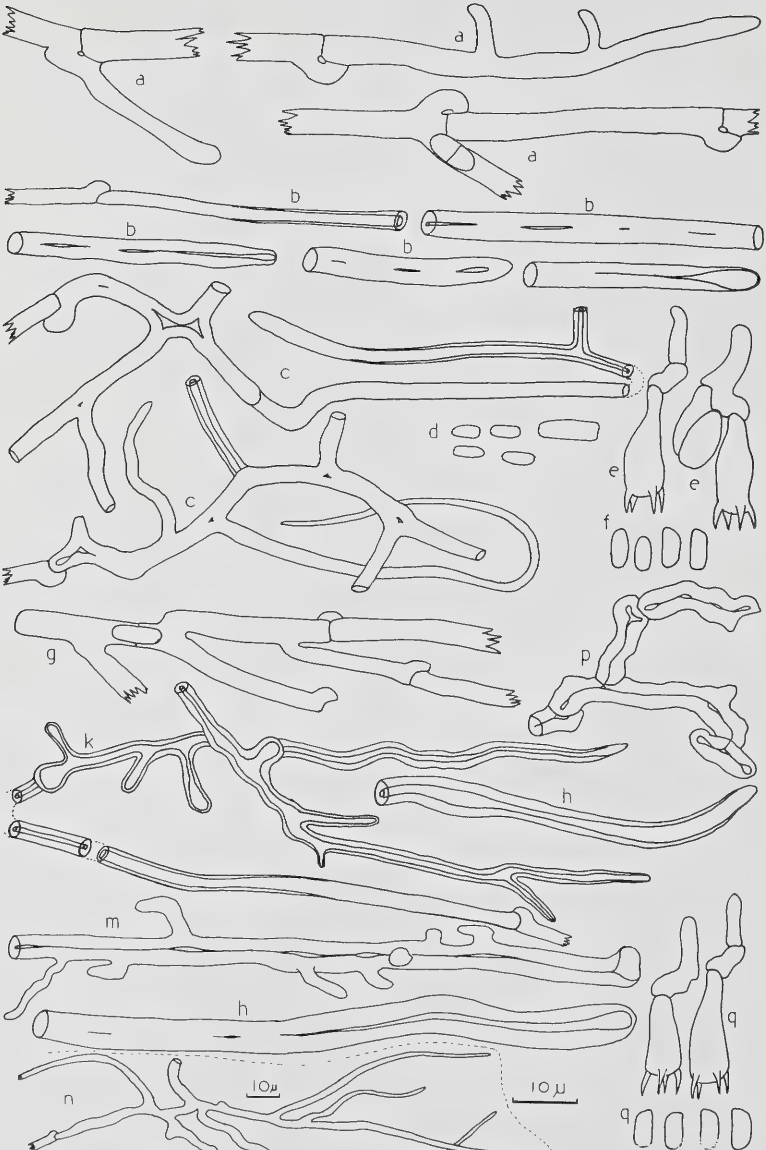

FIGURE 30

Aug. 1915; 31586, on dead wood, Pretoria, Tvl. 1915; 31623, on rotten logs, Knysna, C.P., Jan. 1916; 31685, on rotten logs Pietermaritzburg, Natal, Aug. 1916; 31712, on rotten logs, Pietermaritzburg, Natal, Dec. 1916; 31729, on rotten logs, Pietermaritzburg, Natal, Dec. 1916; 31820, on rotten logs, Umgeni, Natal, April 1917; 31974, on living *Trema* sp., Durban, Nov. 1917; 32030, on *Celtis kraussiana*, Durban, Nov. 1917; 33072, on *Acacia mollissima*, Donnybrook, Natal, June 1940; 33905, on dead wood, Scottburgh, Natal, Feb. 1943; *42446, on *Acacia mearnsii* stump, Graskop, E. Tvl., Feb. 1961; *42449, on *Acacia mearnsii* stump, Kaapse Hoop, Tvl., Feb. 1961; *42459, decaying hardwood log, Blouberg, Tvl., Apr. 1961; *42723, on living *Acacia* sp., Rustenburg, Tvl., Aug. 1953.

Herb. STE: 262, at base of *Acacia* tree. Pretoria; 575, at base of *Acacia* tree, Howick Natal; 2267, at base of *Acacia* tree, Pietermartizburg, March 1930; 2755, at base of *Acacia* tree, Maclear, C.P.

Interfertility studies

In order to determine the type of interfertility of this species, a set of 16 cultures, each grown from a single basidiospore, was made from spores collected from a fructification formed in a culture of PRE 42446. By pairing these cultures in all possible combinations, it was found that *Trametes meyenii* has the tetrapolar type of interfertility with allelomorphs for heterothallism at two loci. The results showing the distribution of mating types among the single spore mycelia are presented below in Table 6.

The conspecificity of other collections of *Trametes meyenii* of which cultures were available, was tested by means of the "Buller phenomenon". Two mycelia of single spores of opposing mating types, PRE 42446 — 3 and PRE 42446 — 14, were used. Seven days after placing the dikaryotic mycelia on the plates on which the above haploid mycelia were growing, the haploid mycelia were examined for clamp connections at three different positions along their periphery. Clamp connections, indicating dikaryotization of the single spore mycelium by the added dikaryotic mycelia, were found in very position. Collections of *Trametes meyenii* numbered PRE 42449, PRE 42459 and PRE 42732 were demonstrated to be conspecific with PRE 42446 (Fig. 29 e).

Discussion

As described above, the cultural characters agree with an earlier description (Van der Westhuizen, 1958) but the hyphae are described in greater detail. Besides the thin-walled, nodose-septate hyphae, two types of fibre hyphae, one unbranched, and resembling the "vermiculiform skeletal hyphae" figured by Teixeira (1962 b), the other branched and resembling the "branched fibre hyphae with whiplash-like ends" described by Nobles & Frew (1962) from *Pycnoporus* spp., are present. These characters, as well as the strong positive oxidase reaction of the culture, agree well with the characters of other species in this group, especially with those of *Polyporus versicolor* and *Lenzites betulina;* but the cultures of *Trametes meyenii* form a thicker, smoother and more woolly mat, than those of *Polyporus versicolor* and *Lenzites betulina,* and develop colours not found on the other species. This combination of characters may serve to distinguish cultures of this species from cultures of other species in this group which are otherwise very similar.

Fig. 30.—**Trametes meyenii.** a - f. Structures from cultures: (a) thin-walled nodose-septate hyphae from advancing zone; (b) unbranched fibre hyphae; (c) fibre hyphae with long tapering branches; (d) oidia; (e) basidia; (f) basidiospores.
g - q. Structures from carpophores: (g) thin-walled, nodose-septate hyphae; (h) unbranched fibre hyphae; (k) fibre hypha with branches toward the distal end; (m) fibre hypha with lateral projections; (n) fibre hypha with numerous long, flexuous branches; (p) nodose-septate hypha with thickened walls and numerous short, tortuous branches; (q) basidia and basidiospores.

The presence of the tetrapolar type of interfertility in *Trametes meyenii*, which causes a white rot of hardwood and produces extra-cellular oxidase enzymes in culture, is in full agreement with Nobles' (1958 b) thesis that tetrapolarity is correllated with the production of extra-cellular oxidase in a large group of polypores with simple clamp connections on their thin-walled hyphae.

In the carpophores of *Trametes meyenii* five kinds of hyphae could be distinguished, viz.: thin-walled and thick-walled nodose-septate hyphae, unbranched fibre hyphae, fibre hyphae with one or two branches towards the tip and fibre hyphae with many short, flexuous branches. These latter are the binding hyphae in Corner's (1932 a) terminology but the thick-walled, nodose-septate hyphae as well as the branches of some of the long fibre hyphae also act as binding hyphae. Hyphae which are morphologically and ontogenically different thus contribute to the binding hyphal system. Since the nodose-septate hyphae are regarded as generative hyphae and the unbranched or sparingly branched hyphae as skeletal hyphae (Corner, 1932 a, b; Cunningham, 1946; Teixeira, 1962 b) carpophores of *Trametes meyenii* have a trimitic hyphal system in the terminology of Corner (1932 a, b) and Cunningham (1954).

From the above descriptions it is evident that the structures formed in culture are also present in the carpophores from which they were made. A greater variety of structures are present in the carpophores than in the cultures, a phenomenon also observed in most other species studied. The branched fibre hyphae or binding hyphae from cultures develop longer, less flexuous branches but in morphology approach the binding hyphae of the carpophores more closely than the branched skeletal hyphae.

The characters of the hyphae and construction of the carpophores of *Trametes meyenii* resemble those of *Polyporus versicolor* and *Trametes suaveolens* very closely. In construction the thin forms of *Trametes meyenii* resemble the carpophores of *Polyporus versicolor* by having large numbers of binding hyphae in the upper and lower context. The thick forms, some of which were found to be conspecific with a thin form by means of the "Buller phenomenon" technique, on the other hand have relatively fewer binding hyphae in the upper context and resemble carpophores of *Trametes suaveolens* more nearly Such thick carpophores approach the softer upper surface and feel of those of *Trametes suaveolens* but are never as soft or have so few binding hyphae in the upper context as to be closely similar to the carpophores of *Trametes suaveolens*. *Trametes meyenii* thus appears to be a transitional species between *Polyporus versicolor* L. ex Fr., the type species of the genus *Coriolus* Quél., on the one hand and *Trametes suaveolens* (L. ex Fr.) Fr., the type species of the genus *Trametes* Fr., on the other. This indicates a close relationship between the two generic type species and is evidence in support of Pilát's (1936) and Kotlaba & Pouzar's (1957) inclusion of the genus *Coriolus* in the genus *Trametes* Fr.

Carpophores of *Trametes meyenii* also resemble those of *Lenzites betulina* in the usually lamellate hymenium and to a large extent in hyphal characters and construction, but the carpophores of *Lenzites betulina* do not have fibre hyphae with one or two branches near the tips which are present in the carpophores of *Trametes meyenii, Polyporus versicolor* and *Trametes suaveolens*. In respect of the characters of the other hyphae and in construction of their carpophores there are close similarities between *Trametes meyenii* and *Lenzites betulina*. It thus appears that *Trametes meyenii* has characters of all three genera, *Coriolus* Quél., *Lenzites* Fr. and *Trametes Fr.*, combined in its carpophores. This supports the view expressed by O. Fidalgo (1957) that the genera *Trametes* and *Lenzites* are congeneric but until the importance of the absence of these fibre hyphae with one or two branches can be determined, it appears desirable to regard them as distinct genera.

The relationship of *Trametes meyenii* to the genus *Coriolus* Quél., was recognized by Cunningham (1950 b) and Imazeki (1952) who independently transferred this species to the genus. Hansen (1960) transferred this species to the genus *Cerrena* Mich. ex S. F. Gray but the carpophores of the type species of this genus, *Cerrena unicolor* (Bull. ex Fr.) Murr. was shown to consist entirely of nodose-septate hyphae, mostly thick-walled, while nodose-septate, thick-walled hyphae were formed in its cultures (Van der Westhuizen, 1963). *Trametes meyenii* thus has no affinities with the genus *Cerrena* Mich. ex S. F Gray.

Murrill (1907 b) cited *Polyporus meyenii* Klotzsch as a synonym of *Coriolus maximus* (Mont.) Murrill based on *Irpex maximus* Montagne of which the description antedates that of *Polyporus meyenii* by about six years. Overholts (1953) accepted Murrill's synonymy but made the combination *Polyporus maximus* (Mont.) Overholts which was later accepted by Lowe & Gilbertson (1961 b). Lloyd (1918), Imazeki (1952) and Hansen (1960) however regard *Irpex maximus* and *T. meyenii* as distinct species because of differences in the shape of their pores. This matter could not be investigated as the type specimens of these two species were not available for study. For this reason the name *Trametes meyenii* (Klotzsch) Lloyd which is well established in South Africa for the specimens studied, is used here.

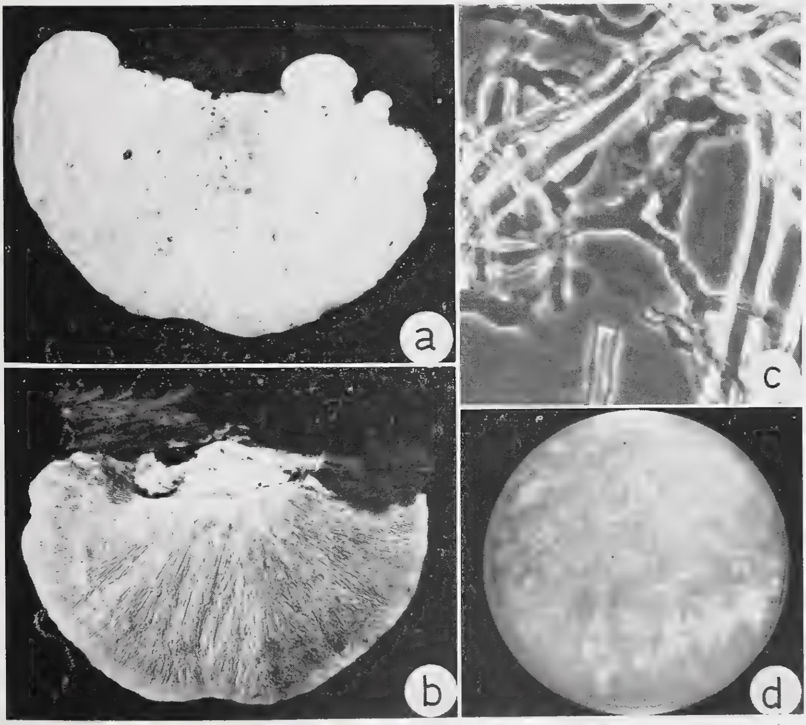

FIG. 31.— **Lenzites palisoti.** (a) Carpophore of PRE 42442, upper surface and (b) hymenial surface; (c) fibre hypha with numerous short branches and unbranched fibre hyphae from context of fruit-body, × 1000 phase contrast; (d) culture of PRE 42442 at six weeks.

Lenzites palisoti *(Fr.) Fries,* Epic. Syst. Mycol. 404, 1838;
Daedalea palisoti Fr., Syst. Mycol. 1, 335, 1821;
Trametes palisoti (Fr.) Imazeki, Bull. Tokyo Sci. Mus. 6, 73, 1943;
Coriolus ambiguus (Berk.) G. H. Cunn., Proc. Linn. Soc. N. S. Wales 75, 216, 1950.

Cultural characters

Growth is moderately fast to slow the mat reaching a radius of 22 mm after one week and covering the plate after three to five weeks. The advancing zone is even at first but becomes uneven due to irregular growth of parts of the margin which result in radially elongate patches projecting beyond the margin. Mycelium mostly submerged, forming irregular milky patches in the agar. Aerial mycelium scanty, at first thin, downy, white becoming submerged but having irregular, radially elongated "islands" of white, farinaceous, downy mycelium which may gradually become tough, sub-felty or coalesce to form irregular, tough, white, sub-felty areas especially in the older parts of the colony. Fertile areas form occasionally on some of these "islands" but are not visibly differentiated. The reverse bleaches slowly and the cultures emit a strong, penetrating, sweetly fragrant odour. On gallic acid and tannic acid media strong diffusion zones are formed and colonies grow to diameters of 32 mm on gallic and 10 mm on tannic acid media in seven days. A strong blue colour is quickly formed when cultures are tested for the presence of extra-cellular oxidase by means of alcoholic gum guaiac solution.

Advancing mycelium: hyphae hyaline, branching, thin-walled, nodose-septate with simple clamp connections, 2.5 — 3.5μ in diameter (Fig. 32 a).

Aerial mycelium: (a) hyphae as in the advancing zone; (b) fibre hyphae hyaline, long, unbranched, refractive, mostly solid or with lumina reduced to an interrupted line, and suddenly expanding at the apex, 2.5 — 4.6μ in diameter (Fig. 32 b); (c) fibre hyphae hyaline, refractive, mostly solid, with a number of long branches, 2.5 — 4.0μ in diameter (Fig. 32 c); (d) fibre hyphae hyaline, mostly solid, tortuous with numerous short, solid, tortuous branches, 2.0 — 3.5μ in diameter intertwined with the long fibre hyphae and binding them into a tough tissue (Fig. 32 d); (e) nodose-septate hyphae with walls thickened or solid, empty or with staining contents and numerous short, tortuous, sub-solid or solid branches, 1.5 — 2.5μ in diameter, often inflated terminally up to 8μ in diameter or with clusters of short lateral projections, mostly solid, at the apex (Fig. 32 e).

Fructifications: basidia long, clavate almost cylindrical 10.0 — 15.0 x 3.5 — 4.0μ with four slender sterigmata 2.5 — 3.0μ long (Fig. 32 f); basidiospores ellipsoid-cylindrical to cylindrical, obliquely apiculate, hyaline, smooth, thin-walled, 3.5 — 6.5 x 2.0 — 2.5μ (Fig. 32 g).

Submerged mycelium: (a) hyphae as in the advancing zone; (b) chlamydospores thick-walled, fusiform, ovoid to sub-globose, 3.5 — 10.0 x 5.0 — 12.0μ.

Carpophore characters

Carpophore annual or reviving, lignicolous, solitary, sessile or sub-stipitate or with reduced, peltate base; pileus reniform to flabelliform or orbicular, variable, tough coriaceous to firm, rigid or woody, up to 20 x 35 x 3 cm; upper surface minutely velutinate or glabrous, tubercular or smooth or radially and concentrically sulcate, white when fresh drying to cream coloured, occasionally dark brown to blackish near the base; margin thin, acute, rounded, undulate or entire, white to cream coloured, sterile underneath; pore surface white to cream coloured poroid

to daedaloid or lenzitoid, 2 — 3 per mm, entire; tubes 2 — 4 mm deep, concolourous; context pure white or creamy white, even-textured, floccose, punky or corky.

Hyphal characters: (1) thin-walled hyphae nodose-septate with simple clamp connections, branching frequently, 1.8 — 3.0μ in diameter (Fig. 32 k); (ii) fibre hyphae hyaline unbranched, narrow near origins, with wide lumina, widening towards middlepart and simultaneously thickening of walls and narrowing of lumina, the latter widening towards the thinner-walled distal ends, aseptate, 3.0 — 6.0μ in diameter, or mostly solid with luminalacking or reduced to a narrow interrupted line which widens suddenly toward the tips (Fig. 32 m); (iii) fibre hyphae with numerous branches, the branches short, very tortuous or longer and tapering somewhat, hyaline, with thickened walls and conspicuous lumina or sub-solid with lumina lacking, aseptate, 1.5 — 3.5μ in diameter (Fig. 32 n); (iv) nodose-septate hyphae sub-solid or solid with short, tortuous branches, 1.5 — 3.5μ in diameter (Fig. 32 p); (v) fibre hyphae sub-solid or solid with two or three long branches arising over a short distance of main stem, 3.0 — 6.0μ in diameter (Fig. 32 q); (vi) short fibre hyphae with terminal clusters of branches with prominent lumina projecting into the hymenium, 1.0 — 3.0μ in diameter (Fig. 32 s).

Hymenium: basidia narrowly clavate, 18.0 — 24.0 x 4.5 — 6.0μ with four slender sterigmata up to 3.0μ long (Fig. 32 t); basidiospores cylindrical, smooth, hyaline, thin-walled, 5.0 — 7.0 x 2.0 — 2.4μ (Fig. 32 x); cystidioles occasional, narrowly cylindrical, hyaline, thin-walled, with deeply staining contents, 20.0 — 30.0 x 1.0 — 2.0μ and arising from the basidial fascicles (Fig. 32 y).

Construction. At the margin the carpophore consists of long, hyaline, unbranched, fibre hyphae more or less parallel to each other and slightly intertwined. Numerous branching and anastomosing, thin-walled, nodose-septate hyphae from which the fibre hyphae arise are intertwined and interwoven with them deeper in the tissues. Behind the margin in the upper context, the unbranched fibre hyphae turn towards the upper surface. Branched fibre hyphae (binding hyphae) with fairly wide lumina and the branches fairly long and interwoven with the fibre hyphae across their direction of growth, become increasingly numerous towards the upper surface. In the upper context the long, unbranched, fibre hyphae are mostly solid and run parallel to each other towards the upper surface where their ends are packed at a common level to form the finely pubescent surface of the younger part of the carpophore. At the upper surface, thin-walled, hyaline branching and anastomosing, nodose-septate hyphae become very numerous. They are tightly intertwined and interwoven with the fibre hyphae to form the smooth, glabrous, upper surface which becomes covered with a very thin, hyaline layer of lacquer-like material over the older parts of the carpophore The dark patches on the upper surface of some specimens, consist of the ends of fibre hyphae with their lumina dilated at the apex and the luminal contents discoloured to reddish brown or dark grey brown. The ends are embedded in a dark-coloured, resin-like substance.

In the lower context the unbranched fibre hyphae are arranged parallel to the direction of growth of the fruit-body while some turn downward toward the dissepiments. Fibre hyphae with long or short, tortuous branches and sub-solid or solid, nodose-septate hyphae with tortuous branches are interwoven with the unbranched fibre hyphae forming a tough dense tissue. In the lower parts of these tissues and in the dissepiments, thin-walled, nodose-septate hyphae become increasingly numerous, branching and anastomising and bearing basidia in fascicles on the surfaces of the dissepiments. In the dissepiments short fibre hyphae arise, bearing numerous, short, terminal branches which project into the hymenium as pseudocystidia or paraphyses as described by Overholts (1953) (Fig. 32 s).

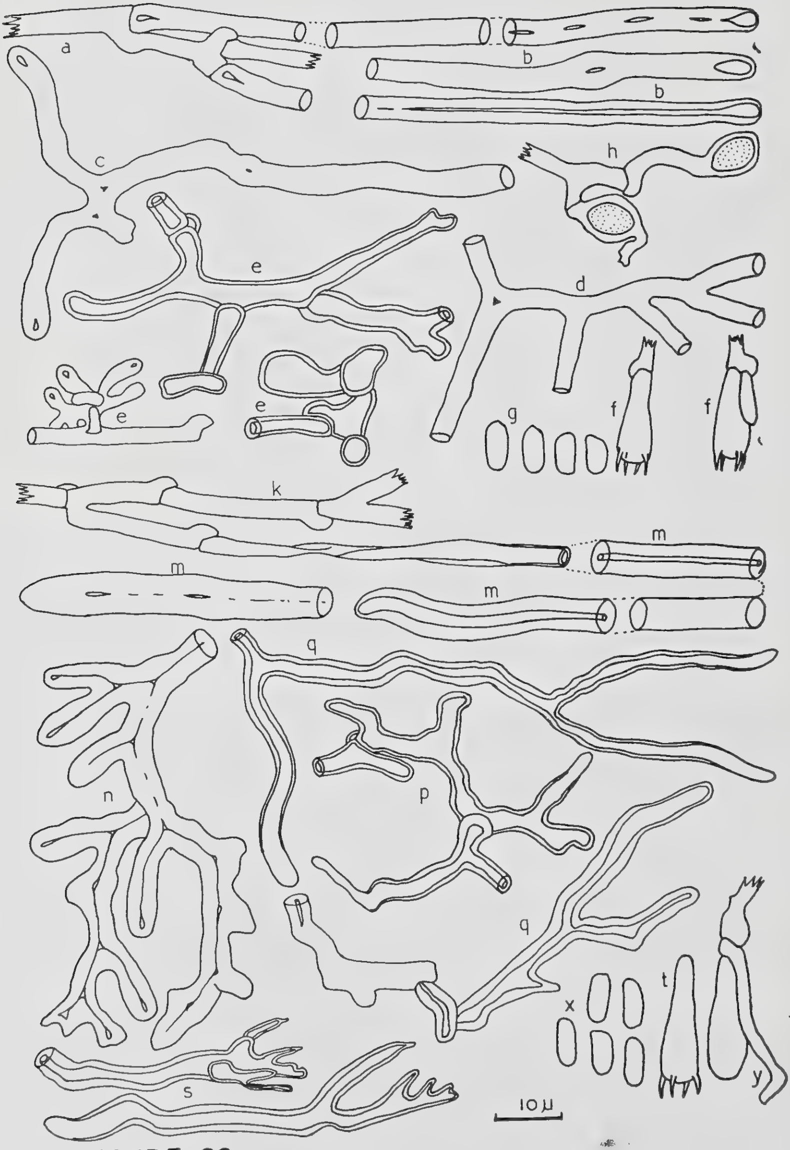

FIGURE 32.

Decay and hosts

This species causes a white rot of the sapwood of hardwood logs. It is widely distributed throughout the warmer regions of the world.

Specimens examined

Herb. DAOM: F5255, on *Quercus* log, Endora, Arkansas, Aug. 1931; F2093, on *Quercus* sp., Buzzards Roost, Alachua Co., Florida, Sept. 1954; *69696, on dead wood, Walker, Louisiana, Aug. 1960.

Herb. Berkeley in Herb. K: *Daedalea ambigua* Berk., from Ohio, (Holotype).

Herb. NY: *Lenzites repanda* Fr., Sierra Leone, Africa, 1889, North Am. Fl. 6003; *Lenzites palisoti* Fr., Somerset East, C.P., Feb. 1876, North Am. Fl. 804; *Lenzites deplanata* Fr., Plants of New Guinea No. 208, Crane Expedition, May 1929; *Lenzites palisoti* Fr., Sydow, Fungi exotica exsicati, 304, Luzon, Mt. Isarog, Dec. 1913; *Daedalea amanitoides* Beauv. 23714, Hulgra, Ecuador, Aug. 1918; *Daedalea amanitoides* Beauv. Dutch Guiana, Herb. NYBG 12; *Daedalea amanitoides,* British Guiana, 13529; *Lenzites applanatus* Fr., Novo Petropolis, Rio Grande du Sul, Brazil, 1924; *Lenzites applanata* Fr., Porto Novo, Sta. Catharine, Brazil, 1928; *Lenzites palisoti* Fr., Baker, Fungi Malayana 242; *Daedalea aesculi,* ex Herb. A.P. L. V. Morgan, No. Am. Fl.; *Daedalea ambigua* Berk, on dead, standing oak trees, Perryville, Mo., Aug. 1885; *Trametes lactea,* Florida, N. W. Calkins 185, Feb. 1886; *Trametes ambigua,* Fern, Putnam Co., Ind., Sept. 1891, L.M. Underwood Coll.; *Daedalea aesculi,* near New Orleans, L.A., F. S. Earle, Aug. 1908, NYBG 113; *Daedalea aesculi,* Batesville, Arkansas, Oct. 1908, 2829; *Daedalea ambigua* Berk., Middlebrove Ill., Sept. 1907, 2518; *Daedalea amanitoides,* Panama Canal Zone, S. L. Meyer, Jan. 1945, 17303.

Herb. PRE: *41, Lenzites repanda,* Zululand; 156, dooie hout, Salisbury, S. Rhodesia; 354, *Lenzites repanda,* dead logs, Zululand; 372, *Lenzites applanata,* Knysna, Jan. 1922; 757, *Lenzites repanda,* ou hout, Knysna; 911, *Lenzites applanata* on dead *Acacia melanoxylon,* Grootvadersbosch, Swellendam; 1235, Hectorspruit, Tvl., July 1916; 1318, Zoutpansberg, Transvaal; 1322, on *Acacia decurrens,* Harden Heights, Natal, April 1911; 1323, on wattle stumps, Cramond, Natal, April 1911; 1648 *Lenzites applanata,* on *Eucalyptus* poles, Tzaneen, July 1924; 1878, on dead tree stump, S. Rhodesia, Aug. 1923; 2370, *Lenzites repanda,* dead stump, Salisbury, S. Rhodesia, Dec. 1924; 2444, *Lenzites repanda,* on old stump, Zimbabwe, Rhodesia, July 1927; 2532, *Lenzites repanda,* Mycological Herbarium, Dept. of Agriculture, S. Rhodesia per J. C. Hopkins, May 1928; 6749, Sydow, Fungi exotica exsiccati No. 101; 8819, Pietermartizburg, Natal, Feb. 1915; 8877, on dead *Acacia karroo,* Pretoria, Tvl., March 1915; 9750, Hectorspruit, Tvl., July 1916; 9957, Fungi Malayana, No. 242; 11550, Buccleugh, Natal, July 1918; 11917, Kyiwaga, Uganda, Aug. 1915; 13155, Flora of the Philippines No. 45; 14932, Victoria Nyanza, Uganda; 15050, on dead *Ocotea bullata,* Hankey, C.P., Nov. 1921; 15488, on dead wood, George, C.P., May 1922; 17805, on *Olea laurifolia,* Knysna, C.P., June 1923; 22055, Somerset East, C.P., 1875; 23350, Alexandra Forest, C.P., July 1927; 27269, Donnybrook, Natal, Aug. 1933; 27707, Donnybrook, Natal, Jan. 1935; 28941, Xumeni Forest, Natal, July 1935; 30101, on *Acacia mollisima,* Butterworth, C.P., Aug. 1937; 30733, Knysna, C.P., Apr. 1949; 31624, Knysna, Cape Province, Jan. 1916; 31671, Ginginhlovu, Natal, May 1916; 33378, on dead wood, Grahamstown, C.P., Sept. 1941; 33923, Mufulira Copper Mines, Zambia, Feb. 1943; 34578, Lothair, E. Tvl., Apr. 1945; 34993, on *Olea laurifolia,* Qudeni Forest, Natal, Feb. 1945; 38738, Petrak, Mycotheca generalis No. 1831; *41534, Hogsback, C.P., May 1956; *42094, on wood, Potgietersrus, Tvl., March 1960; 42432, on dead hardwood, Graskop, E. Tvl., March 1957; *42442, on *Acacia* sp. log, Bushbuckridge, E. Tvl., Feb. 1961; *42531, on hardwood log, Louis Trichardt, N. Tvl., April 1964; *42748, on *Olea laurifolia,* Knysna, C.P., Oct. 1955; 43157, on dead wood, George, C.P., March 1966.

FIG. 32.— **Lenzites palisoti** a - h. Structures from cultures: (a) thin-walled, nodose-septate hyphae; (b) unbranched fibre hyphae; (c) solid fibre hypha with long branches; (d) fibre hyphae with short branches; (e) thick-walled, nodose-septate hyphae with short, tortuous branches; (f) basidia; (g) basidiospores; (h) chlamydospores.

k - y. Structures from carpophores: (k) thin-walled, nodose-septate hyphae; (m) unbranched fibre hyphae; (n) fibre hyphae with numerous, tortuous, short branches; (p) thick-walled, nodose-septate hyphae with tortuous branches; (q) fibre hyphae with branches toward the distal end; (s) short fibre hyphae with terminal clusters of branches; (t) basidium; (x) basidiospores; (y) cystidiole.

Interfertility studies

Spores were obtained from a fruiting area of the culture of PRE 42442. In order to determine the type of interfertility of this species. 16 cultures, each grown from a single basidiospore, were paired in all possible combinations. The results indicate that *Lenzites palisoti* possesses the tetrapolar type of interfertility with allelomorphs for heterothallism at two loci. The mycelia from five single spores did not mate with any one of the other mycelia. Where they were used in pairings, the two mycelia never met even after prolonged incubation but showed signs of mutual aversion and inhibition. The results, showing the distribution of mating types among the single spore mycelia are presented below in Table 7.

The cause of the failure of these five monospore cultures to mate with the others is not known and no attempt was made to determine it. It may be due to the "barrage phenomenon" as described by Vandendries and Brodie (1933) and Brodie (1935, 1936) or to staling effects since it was noticed that these monospore mycelia grew rather poorly in culture and always formed restricted colonies.

Discussion

The presence of nodose-septate hyphae, fibre hyphae and extra-cellular oxidase in its cultures and cylindrical basidiospores in the carpophores, places *Lenzites palisoti* in Group 45. In most respects it agrees in cultural characters with other trametoid species in this group but the rather penetrating fragrant odour given off by the ragged cultures, which produce so much submerged mycelium, serve to distinguish this species from others in this group.

Nobles (1958 b) placed *Lenzites repanda* (Pers.) Fr., (synonymous with *Lenzites palisoti*, Fidalgo & Fidalgo, 1966) in Group 27, among species with simple septate hyphae and a negative oxidase reaction in culture, but she placed *Daedalea ambigua* Berk. (synonymous with *Lenzites palisoti*, Fidalgo & Fidalgo, 1966) in Group 45. Davidson *et al.* (1938) reported the formation of strong diffusion zones by cultures of *Daedalea ambigua* on gallic acid and tannic acid media and the formation of a white rot by the fungus on wood. Van der Westhuizen (1958) also reported a strong, positive, oxidase reaction in cultures of *Lenzites palisoti* and a white rot of wood decayed by this common and widely distributed species.

Carpophores of *Lenzites palisoti* agree in anatomical characters with other species of this group as described above. The nodose-septate hyphae may be thin-walled generative hyphae or may be thick-walled "sclerified generative hyphae" with tortuous branches which form part of the binding system. The fibre hyphae may be unbranched, solid, or have a number of long, flexuous branches which contribute to the binding system or they may be short binding hyphae with numerous, short, tortuous branches. Hyphae which are morphologically and ontogenically distinct thus comprise the binding hyphal system. Because nodose-septate hyphae are regarded as generative hyphae, and because aseptate binding hyphae are present in the carpophores, the fruit bodies of *Lenzites palisoti* have a trimitic hyphal system in Corner's (1932 a, b) terminology.

From the above descriptions it is clear that the structures formed in cultures are also present in the carpophores of *Lenzites palisoti* from which they were made. The chlamydospores are however again the exception but this appears to be the general condition. It is possible that chlamydospores may be formed in the wood decayed by this fungus, which was not available for examination.

Despite its wide distribution, little was known about the anatomical characters of *Lenzites palisoti*. Cunningham (1950 b) placed this species in the genus *Coriolus* Quél, which he had characterized earlier (Cunningham, 1948 c) as having a trimitic hyphal system with nodose-septate generative hyphae, unbranched, aseptate, skeletal hyphae and aseptate, branched, binding hyphae of the bovista type. Overholts (1953) stated that the hyphae in the carpophore of *Daedalea ambigua* Berk. (= *Lenzites palisoti* (Fr.) Fr.) are "mostly simple, thick-walled with no cross-walls or clamps, 3 — 7μ in diameter; sometimes much branched hyphal complexes present."

Fidalgo & Fidalgo (1966) reported this species to possess a trimitic hyphal system with "generative hyphae thin-walled, hyaline . . . with clamp connections", "skeletal hyphae thick-walled, . . . unbranched, straight or wavy, never twisted . . . with no clamps or simple septa; binding hyphae thick-walled to solid, . . . much branched, very tortuous, curled, with no clamps or simple septa". These reports agree in most respects with the descriptions given above but these authors do not mention the presence of either the branched, thick-walled nodose-septate "binding hyphae," which are numerous in the lower context and trama of the fruit-bodies, or the branched fibre hyphae which are present in the lower parts of the carpophores.

Fidalgo & Fidalgo (1966) cited the full synonymy of this widely distributed species. From this list it is clear that the numerous specific epithets have been combined with the genera *Daedalea* Fr., *Trametes* Fr. or *Lenzites* Fr. by most authors. Fidalgo & Fidalgo (1966) regard *Daedalea elegans* Spreng. ex Fr. as the correct name for this fungus in view of O. Fidalgo's (1957) earlier argumentation that the genera *Lenzites* Fr. and *Trametes* Fr. are synonymous with *Daedalea* Fr. In that argumentation *Lenzites palisoti* was quoted as the species in which the morphological characters of all three genera were combined. Comparison of the cultural characters and hyphal characters of *Lenzites palisoti* with those of the type species of *Daedalea* Fr., *Daedalea quercina*, however reveal many differences. Cultures of *Daedalea quercina* do not produce extra-cellular oxidase like those of *Lenzites palisoti*, and form nodose--septate hyphae with irregularly thickened walls which are absent from the cultures of *Lenzites palisoti*. These nodose-septate hyphae with irregularly thickened walls are also present in the carpophores of *Daedalea quercina* but absent from those of *Lenzites palisoti*. In carpophores of the latter species, fibre hyphae with numerous tortuous branches (or binding hyphae) are present in large numbers but are absent from those of *Daedalea quercina*. Since such differences in the kinds of hyphae present in carpophores indicate phylogenetic dissimilarities and are regarded by Corner (1953), Cunningham (1954), Bondartzeva (1961) and Teixeira (1926 b) as of generic importance, *Lenzites palisoti* cannot be regarded as being congeneric with *Daedalea quercina*. On the other hand, it is evident from the descriptions given above that *Lenzites palisoti* resembles the type species of the genera *Coriolus* Quél., *Lenzites* Fr. and *Trametes* Fr. very closely in respect of cultural and micromorphological characters and construction of their carpophores. Not only are the same types of hyphae present in the carpophores of their respective type species [with the exception of the absence of long fibre hyphae with one or two branches near the distal ends from carpophores of *Lenzites betulina* (L. ex Fr.) Fr.] but the hyphae as well as the basidia and basidiospores show strong similarities in morphology. It is thus evident that *Lenzites palisoti* Fr. has close phylogenetic relationships with these three genera.

In order to determine the taxonomic position of *Lenzites palisoti* the construction of its carpophores and their variability in texture should be considered in relation to these characters of the carpophores of the type species of these

three genera. Different specimens of *Lenzites palisoti* may vary considerably in thickness and texture. In thin, leathery carpophores of *Lenzites palisoti*, the construction may resemble that of typical, thin, leathery specimens of *Polyporus versicolor* with very numerous binding hyphae in the tissues. In the thicker specimens the construction approaches that of carpophores of *Lenzites betulina* where binding hyphae are relatively less numerous in the middle context, or even *Trametes suaveolens* where binding hyphae are absent from the upper context. In view of this variability in construction together with the well known variability in the configuration of its hymenial surface, it appears that *Lenzites palisoti* is an intermediate form between *Lenzites betulina*, *Polyporus versicolor* and *Trametes suaveolens*. This is further evidence in support of the view that these latter three species are congeneric and that the genera of which they are the type species, are synonymous with *Trametes* Fr. If this view is accepted, then *Lenzites palisoti* should be included in the genus *Trametes* Fr. as *Trametes elegans* (Spreng. ex Fr.) Fr., (cf. Fidalgo & Fidalgo, 1966).

Polyporus occidentalis *Klotzsch*, Linnaea 8, 486, 1833;

Trametes occidentalis (Klotzsch) Fr., Epicrisis, p. 491, 1838;

Coriolopsis occidentalis (Kl.) Murr., Bull. Torrey Bot. Club, 32, 358, 1905;

Coriolus occidentalis (Kl.) G. H. Cunn., Proc. Linn. Soc. N.S. Wales, 75, 233, 1950.

Cultural characters

Growth is rapid, the mat reaching a radius of about 40 mm in one week and covering the plates in two weeks. The advancing zone is even or slightly bayed with the mycelium appressed for about 1 mm behind the extreme margin, then raised to form a woolly ridge about 1 cm wide across the plate, but becoming somewhat more felty and less raised behind this ridge towards the inoculum. A second and third woolly ridge may be formed across the mat between the first ridge and the edge of the plate. The mat is white at first but the ridges turn "light buff" to "cream color" within a week. As the mat ages, the raised ridges become more compact and tough, felty and darken in colour to "naples yellow" or almost "mustard yellow" after four weeks, becoming lacunose and uneven or, may develop irregular, raised lumps of tough, compact mycelium. Thinner areas of the mat become more farinaceous woolly to somewhat felty and remain white but eventually develop the "cream colour" to 'light buff" colour of the raised ridges. At six weeks the mat around the inoculum is mostly farinaceous felty, white or with patches of "maize yellow" and traversed by thick, raised, felty ridges, lacunose or roughened, mostly "cream buff" or "ochraceous buff" in colour and with irregular, smooth, velvety lumps of the same colour on them or at the sides of the dish. Occasionally depressions develop on these lumps from which acicular spines, up to 2 mm high, arise, bearing basidia and spores. The reverse of the colony bleaches quickly and remains so; a faintly fragrant odour is given off. A strong blue colour is quickly produced when the culture is tested for the presence of extra-cellular oxidase enzymes by means of alcoholic gum guaiac solution.

Advancing mycelium: hyphae hyaline, simple or branching, nodose-septate with simple clamp connections, thin-walled, with deeply staining contends, 2.5 — 5.0μ in diameter (Fig. 34 a).

Aerial mycelium: (a) hyphae as in the advancing zone; (b) fibre hyphae long, unbranched, thin-walled and narrow at the origins, widening towards the middle

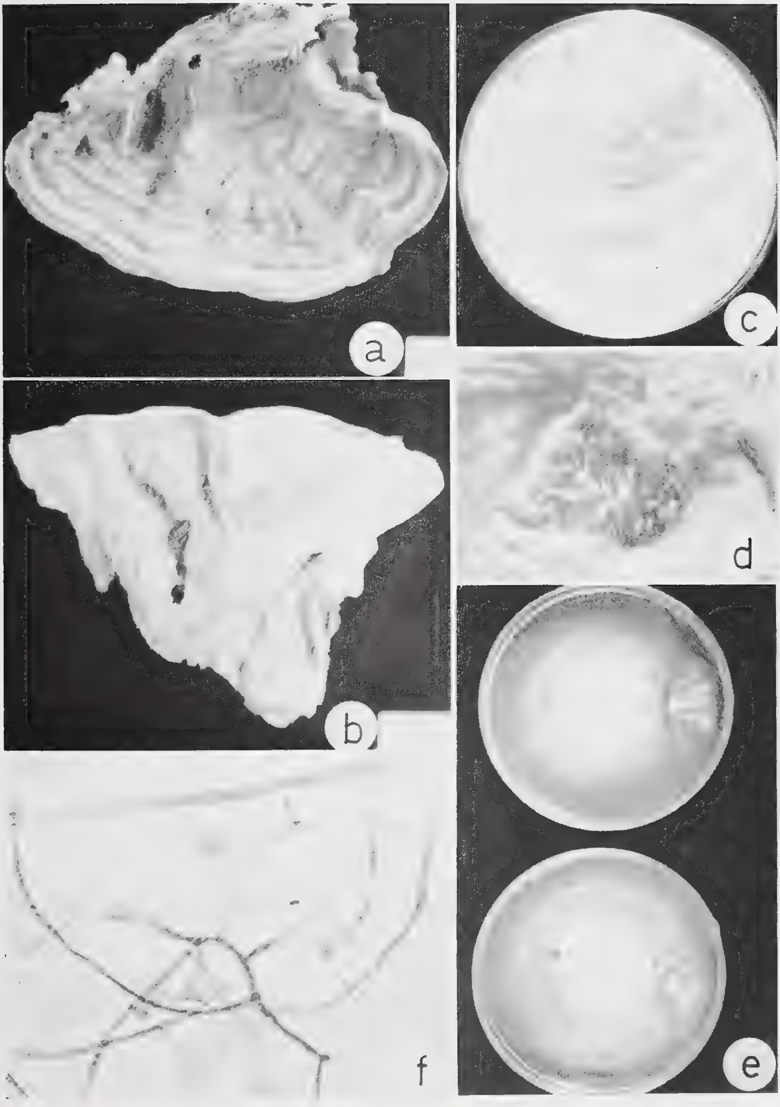

FIG. 33.—**Polyporus occidentalis.** (a) Upper surface and (b) hymenial surface of PRE 42450; (c) culture of PRE 42450 at six weeks; (d) fructification in culture; (e) "Buller phenomenon" plates of PRE 42863 × PRE 42445; (f) branched and unbranched fibre hyphae from culture of PRE 42863.

part with simultaneous increase in thickness of the walls which become faintly yellowish brown and narrowing of the aseptate lumina, often with contents staining in phloxine, but widening toward the thinner walled tips, 4.5 — 6.5μ in diameter at widest part (Fig. 34 b); (c) fibre hyphae hyaline, narrow, branching, the branches long, flexuous, of even diameter, walls thick, lumina prominent or reduced to interrupted lines, 0.7 — 1.5μ in diameter (Fig. 34 c); (d) oidia hyaline, cylindrical, ends rounded, 2.5 — 7.5 x 1.5 — 4.0μ (Fig. 34 d).

Fructification: basidia hyaline, narrowly clavate, 14.5 — 20.0 x 3.6 — 5.5μ and bearing four, straight, sterigmata, 3.0 — 3.6μ long (Fig. 34 e); basidiospores hyaline, cylindrical, smooth, thin-walled, 4.5 — 7.0 x 2.0 — 2.5μ (Fig. 34 f).

Submerged mycelium: (a) nodose-septate hyphae as in the advancing zone; (b) oidia as in the aerial mycelium.

Carpophore characters

Carpophore annual, lignicolous, solitary or grouped; pileus sessile to effused-reflexed, applanate or dimidiate frequently concave above and imbricate, tough coriaceous to firm and rigid, 6 — 13 x 1.5 — 8 x 0.1 — 1.0 cm; surface tomentose or hirsute, strongly concentrically sulcate, occasionally tuberculate, "olive brown", "buffy brown", "tawny olive" or "chamois" with zones of "ochraceous buff", "cinnamon buff" and "verona brown"; margin acute, undulate concolourous with upper surface or darker; pore surface "light ochraceous buff" drying to "cinnamon buff", or "ochraceous buff", pores rounded at first but later angular to elongate in older parts, 1 — 3 per mm; dissepiments mostly even, thick or thin; tubes "ochraceous buff", 1 — 2 mm deep, decurrent on the bases of the pileus, sometimes stuffed; context "pale ochraceous buff" to "ochraceous buff", zonate, fibrous corky to sub-woody, 0.5 — 8 mm thick.

Hyphal characters: carpophores consist of: (i) nodose-septate hyphae hyaline, branching, thin-walled, 2.2 — 3.0μ in diameter (Fig. 34 g); (ii) fibre hyphae long, unbranched straight or somewhat flexuous, sub-hyaline to pale yellowish-brown, thick-walled, the lumina aseptate, wide at the extremities but narrow or partly occluded near the middle portion, with or without staining contents, 3.0 — 7.5μ in diameter and arising from thin-walled, nodose-septate hyphae (Fig. 34 h); (iii) fibre hyphae long, straight or flexuous with one to three branches towards the distal end, the branches flexuous, thick-walled, sub-hyaline to pale yellowish brown, lumina prominent, aseptate, 2.0 — 5.2μ in diameter (Fig. 34 k); (iv) fibre hyphae hyaline with numerous long, tortuous, tapering branches mostly solid or lumina much reduced, arising from a short length of main stem, the branches interwoven with other hyphae, 1.0 — 4.0μ in diameter (Fig. 34 m).

Hymenium: basidia hyaline, long clavate almost cylindrical with four sterigmata, 14.5 — 18.0 x 3.6 — 4.5μ; sterigmata 3.0 — 3.6μ (Fig. 34 n); basidiospores cylindrical, hyaline, smooth, thin-walled, 4.5 — 7.0 x 2.0 — 2.5μ (Fig. 34 p); hyphal pegs conical, projecting 40 — 50μ beyond the level of the basidia.

Construction. The margin consists of long, unbranched fibre hyphae with thickened walls and prominent lumina, and arranged more or less parallel or slightly intertwined. Also intertwined with the fibre hyphae are numerous deeply staining, branching, nodose-septate, thin-walled hyphae from which they arise. Behind the margin the context consists mainly of fibre hyphae. In the upper context the fibre hyphae are mostly straight with partly thickened, pale yellowish-brown walls and prominent lumina. They are parallel in arrangement and loosely intertwined. Occasional thin-walled, nodose-septate hyphae are present among them. At the upper surface a somewhat denser layer of tissue is present which consists of branching, thin-walled, nodose-septate hyphae and hyaline, fibre hyphae with

many thick-walled or solid branches, intertwined with the unbranched fibre hyphae. The unbranched fibre hyphae project beyond this layer to form the dense, tomentose upper surface of the carpophore. In the lower context the construction of the tissues is similar but the tissues become more dense towards the pores. Long unbranched fibre hyphae, 3.5 — 4.5μ in diameter, with the lumina narrow or partly occluded, turn downwards into the trama of the dissepiments where they become interwoven with hyaline much-branched fibre hyphae with solid or sub-solid branches, and branched, thin-walled, nodose-septate hyphae to form a dense, tough, homogeneous tissue. In the dissepiments, thin-walled, nodose-septate hyphae ramify throughout the tissues, branching repeatedly and forming numerous short branches bearing clusters of basidia at the hymenial surfaces of the tubes.

Decay and hosts

Polyporus occidentalis causes a white rot of hard-wood logs in dry, exposed positions in sub-tropical areas.

Specimens examined

Herb. DAOM: 31731, on *Cola cordifolia*, Jasikan, Tongoland, May 1949; 38997, on wood, Rest Pew, Manchester, Jamaica, Feb. 1945; 52393, Municipio Benjamin Constant, Brazil, Aug. 1955.

Herb. PRE: 1372, on wattle stump, Cramond, Natal, Apr. 1911; 1697, on fence post, Letaba Drift, Zoutpansberg, Tvl., Aug. 1911; 5645, on fence post, Winkelspruit, Natal, Feb. 1912; 6685, on *Citrus simensis* stump, Nelspruit, Tvl., May 1913; 6926, on *Celtis rhamnifolia*, Lusikisiki, Transkei, Sept. 1913; 8818, on *Celtis rhamnifolia*, Pietermaritzburg, Natal, Feb. 1915; 9204, on *Celtis rhamnifolia*, Pietermaritzburg, Natal, Dec. 1915; 9482, on *Celtis rhamnifolia*, Inanda, Natal, Dec. 1915; 11249, on *Celtis rhamnifolia*, Durban, Natal, Nov. 1916; 11254, on *Pyrus malus*, Wolhuters Kop, Tvl., Feb. 1919; 13169, Flora of the Philippines No. 491, Nov. 1916, 13367, Flora of the Philippines No. 19101, Nov. 1916; 14072, Flora of Victoria Nyanza, Uganda, Nov. 1916; 14892, Flora of Kenya, Nov. 1916; 15016, on stump, Pretoria, Tvl., April 1921; 15051, on wood, Selati River, E. Tvl., Nov. 1921; 15573, on wood, Durban, Natal, Nov. 1916; 15582, on *Rhus viminalis*, Branders High Forest, Aug. 1915; 23349, on wood, Alexandria, July 1927; 25491, on dead trunk, Kasane, Bechuanaland, July 1930; 25917, on tree stump, Zoutpansberg, Tvl., Dec. 1929; 26324, on tree stump, Elim Mills, Zoutpansberg, Tvl., March 1932; 26380, on tree stump, Eshowe, Natal, Jan. 1916; 26385, on tree stump, Margate, Natal, Feb. 1911; 27606, on tree stump, Pietermartizburg, Natal, Feb. 1934; 28250, Fungi Venezuelani No. 418, H. Sydow; 28707, on *Prunus domestica*, Pietermaritzburg, Natal, Nov. 1934; 30102, on *Acacia mollissima*, Willowvale Plant., C.P., July 1937; 30283, East Afr. Agric. Res. Stat., Amani, No. 1084; 30820, on dead wood, Port St. Johns, Aug. 1937; 31631, on dead wood, Eshowe, Natal, Jan. 1916; 31649, on dead wood, Durban, Natal, May 1916; 31675, on dead wood, Gingindhlovu, Natal, June 1915; 31686, on *Albizzia fastigiata*, Durban, Natal, Sept. 1916; 31693, on dead log, Durban Natal, Sept. 1916; 31701, on dead log, Botanical Garden, Durban, Natal, Oct. 1916; 31856, on dead log, New Germany, Natal, April 1917; 31857, on dead log, New Germany. Natal, Apr. 1917; 31945, on dead log, Stella Bush, Durban, Natal, Apr. 1917; 31980, on dead log, Pietermaritzburg, Natal, Nov. 1917; 35561, on *Nerium oleander*, dead branch, Pietermaritzburg, Sept. 1946; 33563, on *Brachystegia* log, Mufilira, Rhodesia, March 1942; 33754, on *Afzelia quanzensis*, Moçambique, Nov. 1942; 33991, on *Salix* sp. wood, Pietermaritzburg, Natal, 1943; 34373, on dead wood, Lake St. Lucia, Natal, 1935; 34376, on dead wood, Lake St. Lucia, Natal, 1935; 34461, on dead wood, Kazungulu, July 1930; 34558, on dead log, Kirstenbosch, Cape Prov., June 1934; 41357, on *Citrus aurantifolia*, Herb. C.M.I. no. 49391; *42144, on hardwood log, Honeydew, Johannesburg, Jan. 1961; *42445, decaying hardwood, F. C. Erasmus Nat. Reserve, E. Tvl., Feb. 1961; *42450, decaying hardwood, White River, Tvl., Feb. 1961; *42863, on *Pinus* sp. log, Bushbuckridge, E. Tvl., Feb. 1961.

Herb. STE: 104, on *Pinus*, near Durban, Natal; 151, on old stump, Durban, Natal; 275, on dead logs, Durban, Natal; 284, on dead logs, Zululand, Natal; 289, on dead logs, Zululand, Natal; 558, on dead *Persea gratissima;* 735, on dead *Persea gratissima*, Natal; 751, on dead *Persea gratissima*, Durban, Natal; 764, on dead *Persea gratissima*, Durban, Natal; 797, on old stump, Durban, Natal; 1043, old stumps, Ngare Mutoni, E. Africa, July 1922; 2415, on dead stump in bush, Umtali, Rhodesia; 2446, old stumps, Rhodesia, July 1927; 2553, old stumps, F. Eyles No. 4226, Feb. 1926; 2617, old stumps, Pietermaritzburg, Natal, May 1931.

Interfertility studies

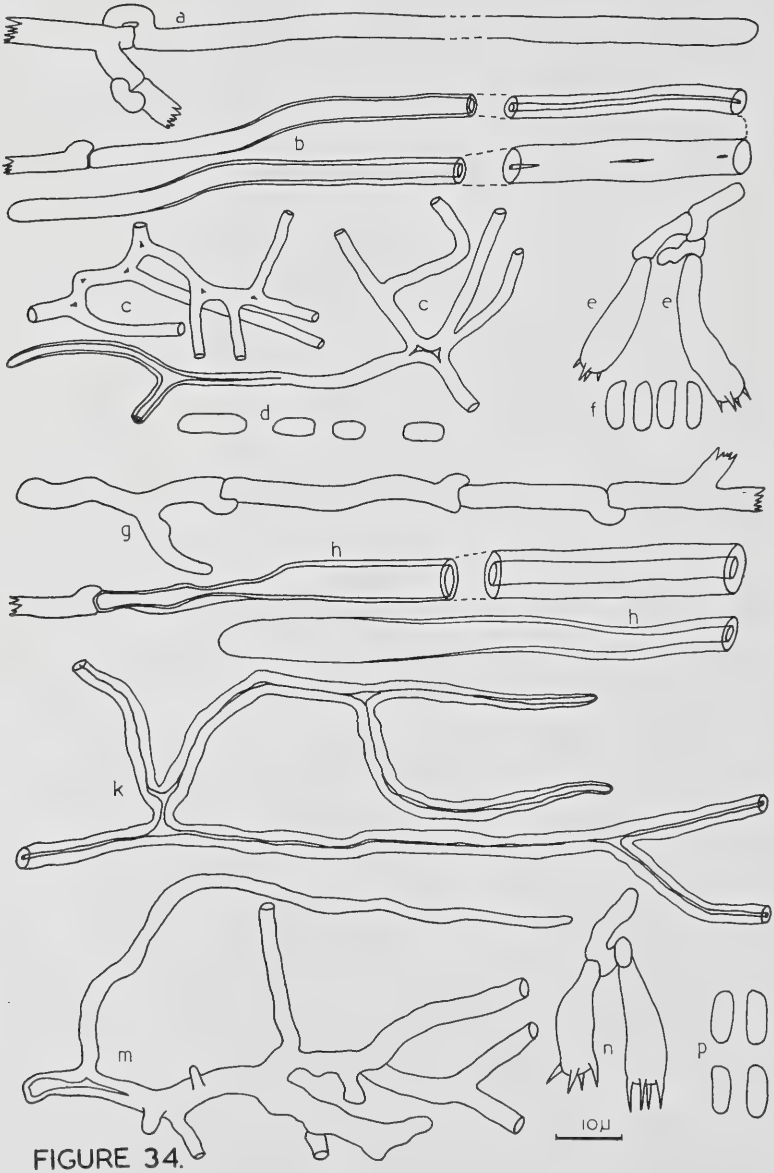

FIGURE 34.

Single basidiospores were collected from a carpophore of collection PRE 42863 kept in a moist chamber. In order to determine the type of interfertility of this species, 16 cultures, each grown from a single basidiospore, were paired in all possible combinations. It was found that *Polyporus occidentalis* has the tetrapolar type of interfertility with allelomorphs for heterothallism at two loci. The results, showing the distribution of mating types among the single spore cultures are presented in TABLE 8.

To test the conspecificity of collections of which cultures were available by means of the "Buller phenomenon", two mycelia from single spores of different mating types, PRE 42363 — 1 and PRE 42863 — 5 were used as haploid mycelia. Dikaryotic mycelia of collections PRE 42445 and PRE 42450 were tested by means of this technique. A set of six plates were prepared for each dikaryotic culture to be tested. Three plates in each set were then inoculated with each haploid monospore culture and incubated for five days. Each set of plates were then inoculated with a small piece of dikaryotic mycelium which was placed near the periphery of the growing haploid colony. After further incubation for four days, the haploid mycelium on each plate was examined for the presence of clamp connections at three positions along its periphery (Fig. 33 e).

Clamp connections were found in every case thus showing that dikaryotization of the single spore haploid mycelia by the added dikaryotic mycelia had taken place and confirming that the collections of *Polyporus occidentalis* numbered, PRE 42144, PRE 42445, PRE 42450 and PRE 42863 are interfertile and therefore conspecific.

Discussion

With the formation of thin-walled, nodose-septate hyphae, thick-walled fibre hyphae and extra-cellular oxidase enzymes in its cultures and its cylindrical basidiospores, *Polyporus occidentalis* fits well into Group 45 (Nobles, 1958 b). The cultures have the general and micromorphological characters of other species described above in this group. Cultures resemble those of *Trametes meyenii* most nearly but the buff coloured areas which develop on the mat and fruiting areas, together with the sub-hyaline to faintly yellowish walls of the fibre hyphae, serve to distinguish cultures of this species from others in the group. This fungus has not been described in culture before but it was included by Nobles (1958 b) in Group 45.

The tetrapolar type of interfertility present in *Polyporus occidentalis* also agrees with that of other species of Group 45 as well as Nobles' (1958 b) thesis that this type of interfertility is present in polypore species of which the thin-walled hyphae are nodose-septate and whose cultures produce extra-cellular oxidase.

The carpophores of this species consist of four types of hyphae, viz. thin-walled, nodose-septate hyphae, unbranched fibre hyphae, fibre hyphae with branches towards the distal ends and fibre hyphae with a number of long tapering branches often arising from a short length of main stem. The latter hyphae appear to be binding hyphae of the bovista type as described by Cunningham (1946) and the

FIG. 34.—**Polyporus occidentalis.** a - f. Structures from cultures: (a) thin-walled nodose-septate hypha from advancing zone; (b) unbranched fibre hypha; (c) narrow fibre hyphae with numerous long branches; (d) oidia; (e) basidia; (f) basidiospores.
g - p. Structures from carpophores; (g) thin-walled, nodose-septate hypha; (h) unbranched fibre hypha; (k) fibre hypha with one to three branches towards the distal end; (m) sub-solid or solid fibre hypha with numerous long, flexuous tapering branches; (n) basidia; (p) basidiospores.

branches of the fibre hyphae with branches towards the distal ends appear to assist in the binding function. The other hyphae correspond to Corner's (1932 a) definition of generative and skeletal hyphae so that carpophores of *Polyporus occidentalis* have a trimitic hyphal system in the terminology of Corner (1932 a) and Cunningham (1946).

The hyphal characters of *Polyporus occidentalis* were described recently by Fidalgo & Fidalgo (1966) who reported a trimitic hyphal system with thin-walled, nodose-septate generative hyphae, "skeletal hyphae thin- to thick-walled usually with a distinct lumen, walls hyaline to yellowish, unbranched, not septate . . .; binding hyphae thick-walled to solid, hyaline, much branched, non-septate". This description agrees well with that given above but these authors did not mention the presence of thick-walled fibre, or skeletal hyphae, with branches toward the distal end which were fairly abundant in the carpophores examined by me. No other description of the hyphal characters of *Polyporus occidentalis* had been published but both Imazeki (1943) and Cunningham (1950 b) included this species in the genus *Coriolus* Quél. thereby implying similarities in hyphal and anatomical characters between this species and *Polyporus versicolor*. From the descriptions it is evident that many similarities in cultural and carpophore characters exist between *Polyporus occidentalis, Polyporus versicolor* and the other species of Group 45 described above. Certain differences, however, exist. *Polyporus occidentalis* is the only species studied in this group in which the fibre hyphae have faintly yellowish brown walls. All the other species have hyphae with hyaline walls. Carpophores of *Polyporus occidentalis* lack the solid, branched, nodose-septate hyphae which are present in the binding hyphal system of carpophores of *Polyporus versicolor, Lenzites betulina, Trametes suaveolens* and other species in this complex. The solid, branched processes formed on nodose-septate hyphae in cultures of *Polyporus versicolor* were not found in cultures of *Polyporus occidentalis.* The binding hyphae of *Polyporus occidentalis* do not have numerous short, curled branches like those of *Polyporus versicolor, Lenzites betulina* and *Trametes suaveolens* but instead have long, tapering branches resembling those of *Trametes cingulata* and the *Pycnoporus* spp. described by Nobles & Frew (1962). Indeed, in respect of hyphal characters, *Polyporus occidentalis* resembles *Trametes cingulata* and *Pycnoporus* spp. more closely than *Polyporus versicolor.* Some of the kinds of hyphae present in carpophores of the type species of *Trametes* Fr., *Lenzites* and *Coriolus* Quél. are thus lacking from carpophores of *Polyporus occidentalis.* Because Bondartseva (1961) and Teixeira (1962 b) regard the absence or presence of different kinds of hyphae as taxonomically important at the generic level, it appears that *Polyporus occidentalis* should not be regarded as congeneric with these three genera.

Murrill (1905) segregated the genus *Coriolopsis* with *Polyporus occidentalis* Klotzsch as type species, from the trametoid group of species on the basis of its dark-coloured context. For reasons advanced above, *Polyporus occidentalis* appears best placed in this genus which however is closely related to the trametoid-corioloid complex of species. It is however not impossible that future studies may show that other hitherto unknown species may reveal a combination of characters common to *Polyporus occidentalis* and other species of the trametoid-corioloid complex, thus offering evidence of congeneric relationship in a series of species.

From the descriptions it is evident that the structures formed in culture are also present in the carpophores from which they were made. The nodose-septate hyphae, fibre hyphae and hymenial structures formed in culture were identical to those of the carpophores but the oidia, which were abundant in cultures, were not found in the carpophores.

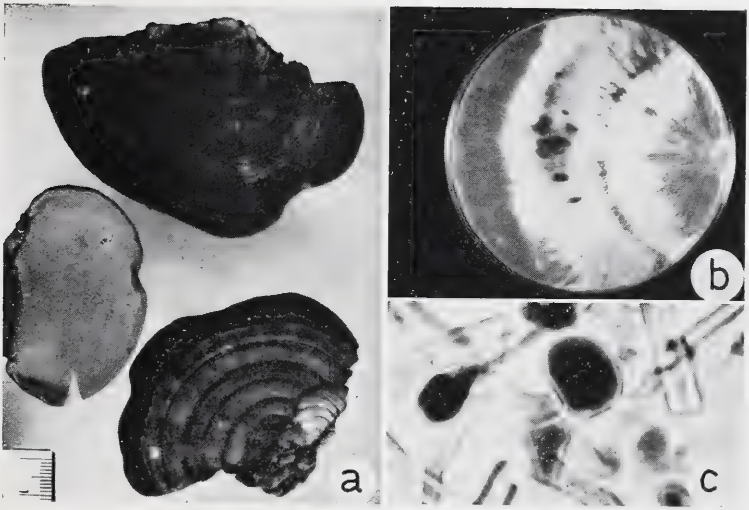

Fig. 35.—**Trametes cingulata.** (a) Carpophores of PRE 27506; (b) culture of PRE 42455 at six weeks; (c) thin-walled hypha with dark-brown resin-like contents from upper surface of carpophore, × 1000.

Trametes cingulata *Berkeley*, in Hook, Journ. Bot. 6, 164, 1854;
Coriolus cingulatus (Fr.) G. H. Cunningham, Proc. Linn. Soc. N. S. Wales 75, 221, 1950.

Cultural characters

Growth is moderately fast the mat reaching a radius of 40 mm in one week and covering the plate after two to three weeks. The advancing zone is even with the hyphae appressed, for one or two millimetres, then raised slightly at the edge of the mat. Mat behind margin at first thin, downy but becoming gradually more dense, somewhat raised, then collapsing somewhat toward the inoculum. Mat smooth at first but developing faint radiating grooves after two weeks with transverse ridges of dense, raised, thin, woolly to felty mycelium which abutt sharply on the thin, downy areas of younger mycelium. The mat is hyaline or white at first and remains so while thickening until, at 6 weeks, it is mostly characterized by areas of tough, dense, somewhat pellicular mycelium around the inoculum, radially sulcate and bordering sharply on thin, downy or sodden mycelium which gradually increases in density to form a transverse zone of dense, felty mycelium over the thin, subfelty mycelium of the newest growth. These zones of dense mycelium may develop irregular, granular-woolly patches which may form fruiting areas bearing minute, waxy, acicular spines, or, irregular lumps of dense, smooth, chamois-like mycelium may form on the sides of the dish or on the areas of thin mycelium and eventually form fruiting areas of minute, erect spines. The reverse of the culture bleaches gradually and a faint, sweetish, fragrant odour is given off. On gallic acid and tannic acid media no growth takes place but a strong diffusion zone is formed on gallic acid medium and a weaker one on

tannic acid medium. A strong blue colour is produced when an alcoholic gum guaiac solution is applied to the mat.

Advancing mycelium: hyphae narrow, hyaline, branching, thin-walled, nodose-septate, 3.0 — 4.0μ in diameter (Fig. 36 a).

Aerial mycelium: (a) hyphae as in the advancing zone; (b) fibre hyphae hyaline more or less straight, unbranched, the walls thick, refractive and lumina prominent, widening at their tips, aseptate, or, occluded and reduced to a thin, interrupted line, 2.5 — 4.5μ in diameter (Fig. 36 b); (c) fibre hyphae as above but with a number of branches over a short length, the branches long, flexuous and tapering, 1.5 — 3.0μ in diameter (Fig. 36 c); (d) oidia hyaline, smooth, cylindrical with rounded ends, 5.0 — 7.0 x 3.0 — 4.0μ (Fig. 36 d).

Fructifications: basidia broadly clavate 12.0 — 25.5 x 4.5 — 6.0μ with four short, straight sterigmata, 2.2 — 3.0μ (Fig. 36 e); basidiospores ovoid to short cylindrical, hyaline, smooth, thin-walled, obliquely apiculate 4.5 — 6.0 x 3.0 — 3.5μ (Fig. 36 f).

Submerged mycelium: (a) hyphae as in the advancing zone but more frequently nodose-septate; (b) chlamydospores intercalary or terminal, sub-globose to ellipsoid, hyaline, thick-walled, 6.0 — 10.0 x 8.0 — 12.0μ (Fig. 36 g).

Carpophore characters

Carpophore annual, lignicolous, mostly solitary, sessile to dimidiate, rarely imbricate, occasionally laterally connate; pileus coriaceous to woody up to 9.0 x 5.0 x 0.3 — 0.7 cm; upper surface glabrescent, concentrically sulcate to tubercular and rough, with fine, irregular cracks or smooth, matt, dark grey to black, azonate or alternating dark and lighter-coloured zones; margin soft velutinate, entire, thick and rounded or thin, acute, pale cream to dark "cream color", sterile below; pore surface pale "cream color" drying darker, glistening, poroid; pores, rounded, 3 — 6 per mm; dissepiments thin, edges entire; tubes concolorous, 0.5 — 2.5 mm deep, not stratified; context white to pale "cream color", even textured, floccose punky to corky, 1.0 — 5.0 mm thick.

Hyphal characters: (i) nodose-septate hyphae hyaline, branching, thin-walled and with deeply staining contents, 2.5 — 3.5μ in diameter, some inflated terminally with contents hard, resin-like, dark-brown (Fig. 36 m); (ii) fibre hyphae hyaline, long, unbranched, walls thick and refractive, widest over middle portion, aseptate, often with dark brown contents at the distal end, or, occluded, and reduced to an interrupted line, 3.5 — 6.0μ in diameter (Fig. 36 k, n); (iii) fibre hyphae thick-walled, hyaline, with one to three branches towards the distal end, lumina prominent, aseptate, 2.5 — 4.5μ (Fig. 36 p); (iv) branched fibre hyphae hyaline, thick-walled, with lumina aseptate, prominent or occluded, branches few or many, long, flexuous, tapering or short, flexuous and arising from a short distance of main stem, 1.5 — 3.5μ in diameter (Fig. 36 q).

FIG. 36.—**Trametes cingulata.** a - g. Structures from culture: (a) thin-walled, nodose-septate hyphae from advancing zone; (b) fibre hypha, unbranched; (c) fibre hyphae with numerous long, flexuous branches; (d) oidia; (e) basidia; (f) basidiospores; (g) chlamydospores.

h - t. Structures from carpophores: (h) thin-walled, nodose-septate hyphae; (k) unbranched fibre hyphae; (m) inflated thin-walled hypha with dark-coloured contents from upper surface; (n) inflated terminal portion of fibre hypha with dark-coloured contents from upper surface; (p) fibre hypha with one to three branches toward the distal end; (q) solid fibre hypha with numerous long, flexuous, tapering branches; (s) basidia; (t) basidiospores.

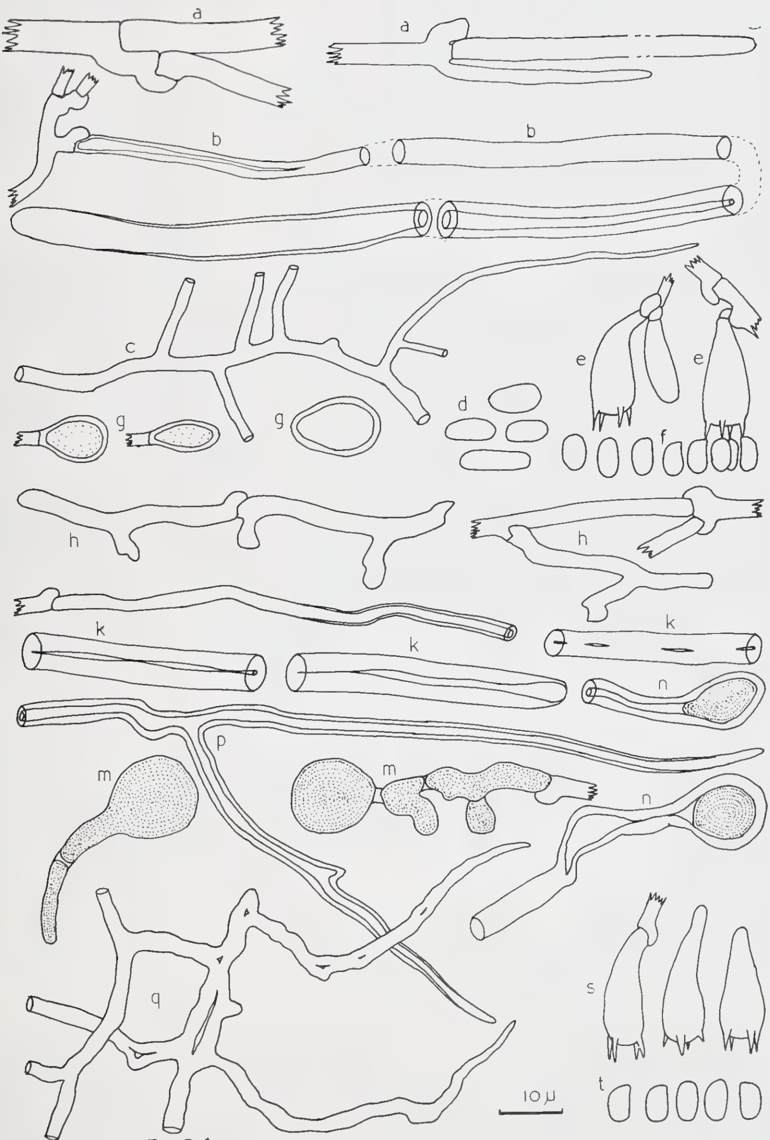

FIGURE 36.

Hymenium: basidia hyaline, long clavate to cylindrical, 12.0 — 22.0 x 4.5 — 6.0μ with four sterigmata 2.5 — 3.0μ long (Fig. 36 s); basidiospores ovoid to short cylindrical, hyaline, smooth, thin-walled, 4.0 — 6.0 x 2.5 — 3.5μ (Fig. 36 t).

Construction. The margin consists mainly of long unbranched fibre hyphae, mostly thick-walled and with aseptate lumina, orientated parallel to the direction of growth of the pileus. Loosely intertwined with them are branching, thin-walled, nodose-septate hyphae from which the fibre hyphae arise Immediately behind the margin in the context, fibre hyphae with one or two long branches or with a larger number of shorter branches, the branches tapering, flexuous and interwoven with the other hyphae, become abundant.

The older part of the context consists mainly of unbranched, sub-solid or solid fibre hyphae in more or less parallel arrangement and slightly intertwined, turning gradually upward towards the upper surface. Branched fibre hyphae, mainly solid, the branches long or short, tortuous, and tapering towards the ends are interwoven with the unbranched fibre hyphae across their direction of growth and bind them into a firm, homogeneous tissue. Occasional lengths of thin-walled, nodose-septate hyphae, mostly empty and collapsed, are present among the others. At the upper surface the ends of the unbranched fibre hyphae are closely packed at a common level. Their lumina are wide and mostly filled with dark-brown, resin-like contents. At the upper surface thin-walled, nodose-septate hyphae are very numerous, intertwined with the fibre hyphae and with ends projecting, often distended and at the same level as the fibre hyphae and filled with dark-brown, resin-like, hard contents (Fig. 36 m). The dark contents of the nodose-septate and fibre hyphae form a zone of about 90μ thick at the upper surface of the pileus. Below this zone the nodose-septate hyphae and many fibre hyphae have deeply staining luminal contents. In the lower context, the long, unbranched fibre hyphae turn downwards into the trama. Fibre hyphae with one or two branches towards the distal part become more numerous, the branches becoming tortuous and fibre hyphae with many tapering branches over a short length of main stem increase in numbers towards the dissepiments where their branches are interwoven with the other hyphae, binding them into a tough tissue. The fibre hyphae are mostly tortuous and tightly intertwined and interwoven into the dense, homogeneous tissue of the lower trama and dissepiments. Most of these fibre hyphae have prominent lumina. Intertwined with the fibre hyphae in the lower trama and dissepiments are the narrow, thin-walled, nodose-septate hyphae, branching freely, the branches short, with numerous clamp connections and becoming very numerous at the hymenial surfaces where they bear basidia in small clusters. The edges of the dissepiments are sterile and consist of fibre hyphae with prominent lumina.

Decay and hosts

Trametes cingulata causes a white sap rot of various species of hardwoods (Banerjee & Naha, 1960 b).

Specimens examined

Herb. PRE: 2127, Pretoria, Jan. 1917; 8799, on *Eucalyptus globulis,* Pietermartizburg, Jan. 1915; 9145, Pietermaritzburg, Natal, Oct. 1915; 11246, on *Acacia mollissima,* Cramond, Natal, Jan. 1916; 12004, on dead log, Kyagwe, Uganda, Jan. 1916; 12465, Limpopo Valley, Transvaal, June, 1919; 14489, Pretoria, Transvaal, Apr. 1921; 14691, Glen, O.F.S., Apr. 1921; 14903, Samu, Kenya; 20289, Malay Peninsula, No. 10858; 20467, Knysna, C.P., Jan. 1925; 20610, dead wood, Pretoria, Transvaal, Aug. 1929; 25492, on dead tree, Kasane, Bechuanaland, July 1930; 26407, on dead wood, Pretoria, Transvaal, Aug. 1929; 26614, on dead tree, Mariental, S.W.A.; 27506, on dead log, Nelspruit, Transvaal, July 1934; 28970, on dead wood, Duiwelskloof, Transvaal, May 1937; 30521, on dead *Eucalyptus* sp., Swartruggens, Tvl., Feb. 1939; 30751, Rustenburg, Transvaal, Jan. 1939; 30876, on dead wood, Xumeni Forest,

Natal, Jan. 1938; 31458, Lobatsi, Bechuanaland, Apr. 1929; 31564, on *Acacia* sp., Balfour, Transvaal; 31628, Krantzkloof, Natal, Jan. 1916; 31629, Cramond, Natal, Jan. 1916; 31655, Ngoye, Natal, May 1916; 34984, on dead stump, Qudeni Forest, Natal, Feb. 1965; 36875, on fallen tree trunks, Amatongas Forest, Moçambique, June 1948; 41356, on *Albizzia zygia*, ex Herb. C.M.I. No. 37382; 41522, on *Olea laurifolia*, Knysna, C.P., Apr. 1965; 41737, on *Acacia mollissima* stump, Richmond, Natal, June 1951; 40297, on dead bark, Potgietersrust, Transvaal, March 1960; 42254, on fallen log, Sabie, Transvaal, Apr. 1962; *42433, on dead hardwood, Blouberg, Transvaal, Jan. 1959; *42448, on dead *Eucalyptus* sp., Bosbokrand, Transvaal, Feb. 1961; *42455, on *Eucalyptus* sp. log, Johannesburg, Tvl. Jan. 1961; *42456, on dead wood, Magaliesberg, Transvaal, Jan. 1961.
Herb. STE: 108, *Acacia mollissima* stump, Krantzkloof, Natal; 750, *Acacia mollissima* stump, Pinetown, Natal; 794, Pretoria; 805, on branch of apricot tree, Pretoria; 817, Lobatsi; 1074, Waterberg, Transvaal, Feb. 1923; 1464, on dry *Eucalyptus* pole, Tzaneen plantation, Transvaal, July 1924; 1671, Potgietersrust, Transvaal, July 1924; 1711, on old wood, Pietersburg, Transvaal, July 1924.

Interfertility studies

Single spores were collected from a fructification formed in a culture of PRE 42448. In order to determine the type of interfertility of this species, 16 cultures, each grown from a single basidiospore, were paired in all possible combinations. Clamp connections formed in the paired mycelia in a manner indicating the tetrapolar type of interfertility with allelomorphs for heterothallism at two loci, in this species. The results showing the distribution of mating types among the single spore cultures are presented below. These results confirm Naha's (1957) report that *Trametes cingulata* has the tetrapolar type of interfertility. This distribution of mating types among the basidiospores is set out in Table 9.

Single basidiospore cultures of other collections of *Trametes cingulata* from South Africa were later obtained from the respective dikaryotic cultures, viz: PRE 42433, PRE 42455 and PRE 42456. In order to determine the conspecificity of these collections with PRE 42448, four cultures, each obtained from a single basidiospore, from each collection, were paired in all possible combinations with four single spore cultures from PRE 42448. In all the paired mycelia, clamp connections developed thus proving that collections PRE 42433, PRE 42448, PRE 42455 and PRE 42456, are interfertile and therefore conspecific.

Discussion

The presence of nodose-septate, thin-walled hyphae and fibre hyphae in cultures which produce extra-cellular oxidase and the possession of cylindrical basidiospores, place *Trametes cingulata* in Group 45 (Nobles, 1958 b). In appearance and texture the mat resembles cultures of *Polyporus versicolor* and *Pycnoporus sanguineus*. From the former species it differs in the presence of the thinner, more fragile, radially striate mat in which nodose-septate hyphae with thickened walls and solid branched processes are lacking. These characters also distinguish *Trametes cingulata* from cultures of other species in this group. Its cultures differ from those of *Pycnoporus sanguineus* as described by Nobles & Frew (1962) by the absence of orange yellow colours. In respect of general appearance of the mat and the structures formed in culture, however, there are many similarities. This description agrees with previous descriptions by Naha (1957), Van der Westhuizen (1958) and Banerjee & Naha (1960 a).

In the carpophores four kinds of hyphae were found, viz: nodose-septate, thin-walled hyphae and aseptate fibre hyphae without branches, or with one to three branches towards the tip or with numerous long tapering branches. These latter appear to be "binding hyphae of the bovista type" as described by Cunningham (1946); but the fibre hyphae with one to three branches also contribute to the binding hyphal system. The carpophores of *Trametes cingulata* thus have a trimitic hyphal system as reported by Cunningham (1950 b) and Farinha (1964).

From the descriptions it is evident that the structures formed in the cultures are also present in the carpophores from which they were made. The nodose-septate hyphae, fibre hyphae and hymenial structures from the cultures are identical to those from the carpophores. Chlamydospores, which were fairly numerous in the cultures, were not present in the carpophores. This discrepancy had also been recorded for other species.

In descriptions of the hyphal characters of *Trametes cingulata*, Banerjee & Naha (1960 b) reported the presence of clamp connections on the thin-walled hyphae of its carpophores. Farinha (1964) reported that secondary hyphae of the carpophore were thin-walled, nodose-septate and, the tertiary hyphae, aseptate, thick-walled, branched and up to 7μ in diameter, while others were much-branched and narrow. Cunningham (1950 b) placed this species in the genus *Coriolus* Quél., which he had characterized as having a trimitic hyphal system with thin-walled, nodose-septate, generative hyphae, thick-walled aseptate, skeletal hyphae and thick-walled, aseptate, much-branched binding hyphae. These reports thus partially confirm the above observations but certain differences are apparent between carpophores of *Trametes cingulata* and those of *Polyporus versicolor* L. ex Fr. and *Trametes suaveolens* (L. ex Fr.) Fr. the accepted type species of the genera *Coriolus* Quél. and *Trametes* Fr. respectively. In carpophores of *Trametes cingulata*, solid or sub-solid, nodose-septate binding hyphae are not present as in the carpophores of these two species. Also, the binding hyphae of *Trametes cingulata* have long, tapering branches which arise over a short length of main stem. Binding hyphae of the other two species are short with fairly short, thick, branches. Hyphae with tapering branches are present in the carpophores of *Lenzites betulina* (L. ex Fr.) Fr., the type species of the genus *Lenzites* Fr. (Cooke, 1959) but they are lateral binding processes or branches of solid, nodose-septate hyphae. Carpophores of *Lenzites betulina* do not possess long fibre hyphae with branches near the end which contribute to the binding system. Carpophores of *Trametes cingulata* thus differ in respect of the types of hyphae present in them from the carpophores of the type species of the genera *Coriolus* Quél., *Trametes* Fr. and *Lenzites* Fr. On the other hand, the binding hyphae in carpophores of *Trametes cingulata* resemble those in carpophores of *Pycnoporus cinnabarinus* (Jacq. ex Fr.) Karst., the type species of the genus *Pycnoporus* Karst. as described by Nobles & Frew (1962) much more closely. Indeed, in cultural characters and hyphal characters *Trametes cingulata* appears to resemble species of the genus *Pycnoporus* Karst. more than they do those of the genera *Trametes, Coriolus* and *Lenzites* but lack the characteristic orange-red colours which distinguish species of the genus *Pycnoporus*. Species of the genus *Pycnoporus*, however, apart from their orange-red colours, have cultural characters which agree with those of Group 45 (Nobles, 1958 b) while their carpophore characters agree in many respects with those of the type species of the genera *Coriolus, Trametes* and *Lenzites*.

The cultural and carpophore characters of *Trametes cingulata* thus agree in many respects with those of the type species of the genera *Coriolus, Trametes* and *Lenzites*, but lack certain of the types of hyphae which are present in their carpophores. The differences in morphology of the binding hyphae of these species may be of specific significance only but the absence or presence of types of hyphae in carpophores are regarded as of generic importance by Bondartseva (1961), Teixeira (1962 b) and Donk (1964). It thus appears best to regard *Trametes cingulata* as generically distinct from *Trametes suaveolens* until detailed studies of the hyphal characters and hyphal morphology of more species in this group can clarify the significance of such differences in hyphal morphology. The genus in which *Trametes cingulata* Berk. will be more suitably placed, cannot be indicated at present, however.

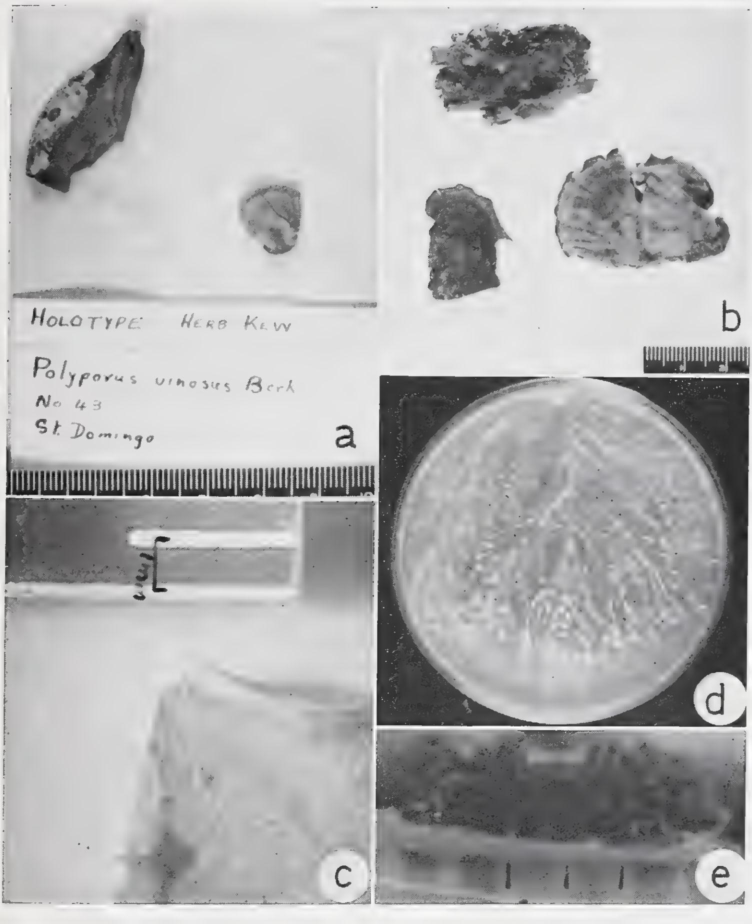

FIG. 37. — **Polyporus vinosus.** (a) Holotype; (b) carpophores from British Honduras; (c) pore surface of holotype; (d) culture of PRE 42154; (e) fructification in culture.

Polyporus vinosus *Berk.*, Ann. Mag. Nat. Hist. 11, 9, 195, 1852;

Coriolus vinosus (Berk.) Pat., Ess. Taxon. 94, 1900;

Nigroporus vinosus (Berk.) Murr., Bull. Torrey Bot. Club 32, 361, 1905;

Fomitopsis vinosa (Berk.) Imazeki, Bull. Gov. For. Expt. Stat., Tokyo, Japan. No. 57, 111, 1952.

Cultural characters

Growth moderately slow to slow, the mycelium reaching a radius of about 10 mm in one week and covering the plate in four weeks. The advancing zone is very uneven with the mycelium mostly submerged and forming hyaline or white plumose outgrowths radiating out from prominent strands which originate from the inoculum. After three weeks small farinaceous pustules appear, scattered over the culture near the inoculum or along the main strands of submerged mycelium, white at first but gradually becoming "light greyish vinaceous" and slowly increasing in size. In an old culture a pad of pubescent "deep livid brown" mycelium developed on the side of the dish, from which thin, lamellar structures grew out laterally, uniting at various points to form daedaloid slits, which in turn rounded off to form minute tubes. A white spore deposit appeared below these tubes five months after inoculation of the plate. The reverse bleaches slowly and a faint mushroomy odour is given off. A strong blue colour is formed when a drop of alcoholic gum guaiac solution is applied to the culture. Strong diffusion zones are formed on gallic acid and tannic acid media but no growth occurs in seven days.

Advancing mycelium: hyphae hyaline, branching, nodose-septate, thin-walled, 2.2 — 3.5μ in diameter (Fig. 38 a).

Aerial mycelium: (a) hyphae as in the advancing zone; (b) fibre hyphae short, mostly unbranched, occasionally with one branch, thick-walled, the walls faintly reddish brown and thickest along the middle part, the lumina prominent, widening towards the extremities, aseptate, 2.2 — 5.0μ in diameter (Fig. 38 b).

Fructification: basidia hyaline, short clavate, 6.6 — 9.0 x 3.6 — 4.2μ with four straight, slender sterigmata 1.8 — 2.4μ long (Fig. 38 c); basidiospores hyaline, allantoid, smooth, thin-walled, 3.0 — 3.6 x 1.2 — 1.6μ (Fig. 38 d).

Submerged mycelium: hyphae hyaline, branching, nodose-septate, thin-walled, 1.5 — 5.5μ in diameter (Fig. 38 e).

Carpophore characters

Carpophore annual, lignicolous, solitary, sessile; thin, dimidiate to reniform, narrowly attached by a scutate disc or laterally connate and broadly decurrent, woody and brittle when dry, 1 — 4 x 3 — 7 x 0.3 — 0.7 cm; surface finely velutinate in young part, then glabrous, concentrically sulcate, mat, "dark vinaceous brown" to "hays brown" becoming "brownish drab" in age; margin acute, rounded, occasionally somewhat lobate, concolorous; pore surface "pale vinaceous drab" to "dark vinaceous brown" or "sorghum brown" poroid; pores angular, 6 — 8/ mm; dissepiments thin, even; tubes up to 2 mm deep, occasionally stratified; context up to 5 mm thick, "sorghum brown", even, homogeneous.

Hyphal characters. Carpophores consist of: (i) nodose-septate hyphae hyaline, branching, thin-walled, with deeply staining contents, 2.2 — 3.5μ in diameter (Fig. 38 f); (ii) nodose-septate hyphae tortuous and branched with walls pale brownish and slightly thickened, with staining contents, or, empty and often with simple septa, 2.5 — 4.0μ in diameter (Fig. 38 g); (iii) fibre hyphae arising from nodose-septate hyphae, straight or flexuous, unbranched, pale smoky brown, thick-walled, lumina aseptate, wide at the extremities narrow or occluded in the middle parts, 2.5 — 6.0μ in diameter (Fig. 38 h).

Hymenium; basidia hyaline, clavate, 6.0 — 9.0 x 3.6 — 4.2μ, with four, straight sterigmata, 1.8 — 2.4μ (Fig. 38 k); basidiospores hyaline, allantoid, smooth, thin-walled, 3.0 — 4.0 x 1.2 — 1.6μ (Fig. 38 m).

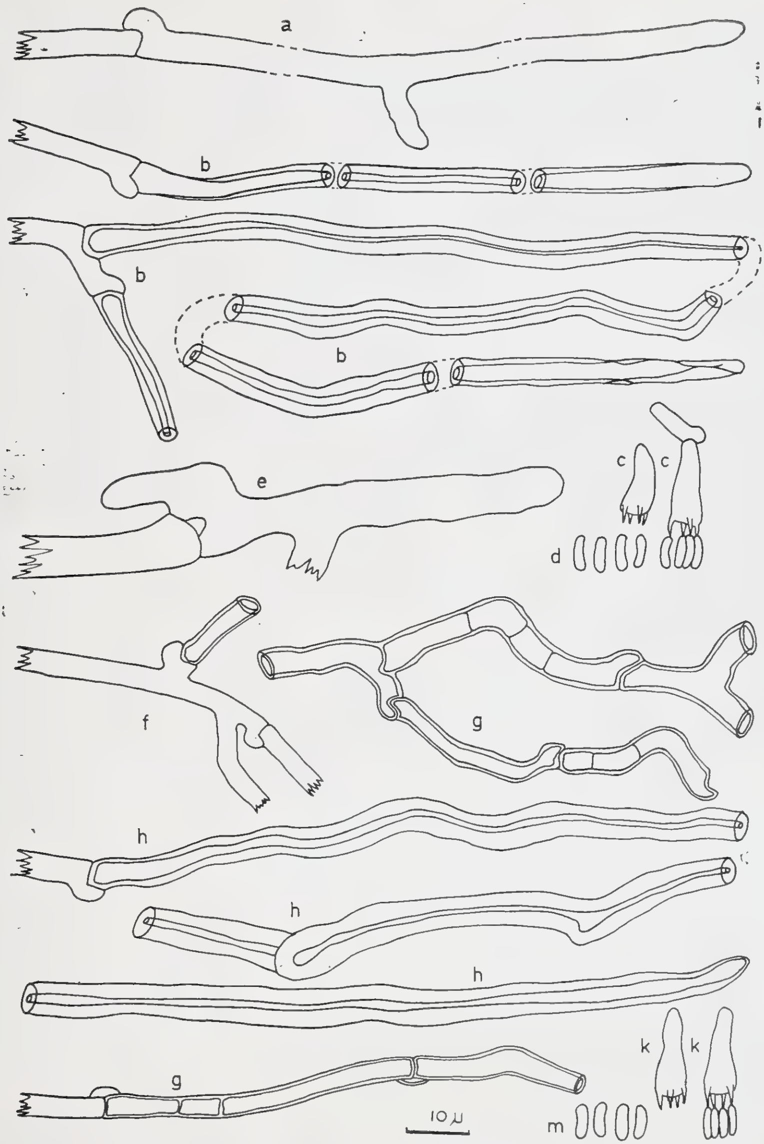

FIGURE 38.

Fig. 38.— **Polyporus vinosus.** a - e. Structures from cultures: (a) thin-walled, nodose-septate hypha from advancing zone; (b) unbranched fibre hyphae; (c) basidia; (d) basidiospores; (e) hypha from submerged mycelium.
f - m. Structures from carpophores: (f) thin-walled, nodose-septate hypha; (g) thick-walled, tortuous, branching nodose-septate hyphae with simple septa; (h) unbranched fibre hyphae; (k) basidia; (m) basidiospores.

Construction. At the margin the carpophores consist mainly of fibre hyphae with prominent lumina and staining contents, arranged parallel to and somewhat intertwined with one another and with branching, hyaline, thin-walled, nodose-septate hyphae. The context consists mainly of unbranched fibre hyphae with pale, smoky-brown, thickened walls, intertwined with one another and with nodose-septate hyphae with pale-brown, thickened walls. In the young parts behind the margin the ends of the fibre hyphae form the pubescent upper surface. Immediately behind this region the hyphal ends are bent over, flattened on to the surface in all directions and agglutinated by a thin layer of a clear, lacquer-like substance up to 30μ thick, into the smooth soft trichocutis (Lohwag, 1940) of the glabrous upper surface. Immediately below the trichocutis numerous hyaline, thin-walled, nodose-septate hyphae are present. The lower context consists mainly of pale, smoky-brown fibre hyphae intertwined with one another and turning downwards towards the trama of the dissepiments, becoming more tortuous and intricately intertwined. Just above the dissepiments the pale brown, nodose-septate hyphae with slightly thickened walls, become more numerous and tortuous, branching frequently and are tightly interwoven with the fibre hyphae, binding them into a tough tissue of which the elements are separated out with difficulty. In the dissepiments the fibre hyphae are tightly intertwined with numerous, hyaline, thin-walled, nodose-septate hyphae which branch freely to bear the basidia at the hymenial surfaces.

Decay and hosts

This species causes a white rot of hardwood logs and stumps in sub-tropical climates.

Specimens examined

Herb. PRE: 12022, on decayed log, Kyagwa, Uganda, July 1916; 14885, on decayed log, Victoria Nyanza, Uganda, July 1916; 27791, on gum tree, Pietermaritzburg, Natal, July 1916; 33125, on rotting log, Mt. Silinda Forest, S. Rhodesia, Jan. 1939; 34092, on old dead tree, Sichele For. Reserve, Zambia, Apr. 1944; 36585, on old dead tree, Sierra Leone, (Deighton No. 2571), March 1947; 40074, on logs in woods, Fungi Cubens., Wright No. 241, March 1947; *42154, on *Eucalyptus* sp. stump, Wilgeboom Plantation, E. Transvaal, Feb. 1961.

Herb. K: Berkeley Herbarium, 1879, *Polyporus vinosus* Berk. No. 43, St. Domingo. (Holotype). *Herb.* STE: 139, on old log, Pietermaritzburg, Natal.

Herb. NY: 132, on prostrate log, Lamao River, Mt. Mariveles, Bataan, Luzon, 1903; 739, Alto Cedro, Cuba, 1903; 764, Cooper's Ranch, El Yunque, Mt. Baracoa, Cuba, 1903; 764, pine log, Gainesville, Fla., coll. Weber, May 1938; 873, on dead wood, Plants of Trinidad, Caroni, North Beach Road, May 1938; 873, on dead wood, Reinkliaar no. 305, St. Domingo, April 1906; 2148, on *Dipterocarpus vernicifluus,* Bosoboso, Rizal, Luson, 1907; 2148, on *Dipterocarpus,* Camp Keithley, Lake Lanao, Mindanao, 1907; 3695, on prostrate log, Mt. Mariveles, Bataan, Luzon, 1904; 7212, on half decayed logs and stumps, Palo, Leyte, Jan. 1906; 16469, Mt. Bulusan, Sorsogon, Luzon, June 1916; 17335, Mt. Bulusan, Sorsogon, Luzon, June 1916; 18444, Los Banus (Mt. Maquiling) Laguna, Luzon, 1917; 18444, British Honduras, 1906; 18444, Troye and Tyre, Cockpit County, Jamaica, Jan. 1909; 18444, Montgomery Co., Alabama, Jan. 1915; 19236, on prostrate log, Attapulgus Station, Decatur Co., Ga., 1903; 178527, Florida Agr. Expt. Station, Planera Hammock, Fla., Feb. 1938; 380, Porto Rico, 1923; 581, Porto Novo, St. Catharines, Brazil, 1928; 581, Herbarium, Expt., Station, Porto Rico Sugar Growers Association, No. 1504, El Dugue, 1914.

Interfertility studies

In order to determine the type of interfertility of *Polyporus vinosus,* sixteen cultures, each obtained from a single basidiospore from a small fructification formed in a culture of PRE 42154, were paired in all possible combinations on malt agar slopes. It was found that *Polyporus vinosus* has the tetrapolar type of interfertility with allelomorphs for heterothallism at two loci. Only three mating types were presented in the mycelia used. The distribution of mating types among the single basidiospore cultures are given in Table 10.

Discussion

Polyporus vinosus had not been described in culture before but with the positive reaction for extra-cellular oxidase, the presence of fibre hyphae and clamp connections on its thin-walled hyphae in culture, it agrees in most respects with Nobles' (1958 b) characters of Group 45. It differs from other species in this group by having fibre hyphae with coloured walls and basidiospores which are allantoid rather than cylindrical. Because no separate group for species with allantoid spores was available this species is placed in Group 45. The cultures of *Polyporus vinosus* differ from those of other species in this group because of the slow growth rate, scanty mycelium and reddish-purple colours of its fibre hyphae. These features, which serve to distinguish cultures of this species, also indicate that it is not well placed in this group and that its phylogenetic relationships may be with species outside this group.

The carpophores of *Polyporus vinosus* consist of three kinds of hyphae, viz: thin-walled, nodose-septate hyphae, thick-walled, nodose-septate hyphae and fibre hyphae. The small number of hyphal types present, suggest a simple construction of the carpophores of *Polyporus vinosus*, but, it was seen that thick-walled, nodose-septate hyphae were interwoven with the fibre hyphae of the lower context, binding them into a dense and very tough tissue. These hyphae cannot be regarded as binding hyphae in the sense of Corner's (1932 a, 1953) and Cunningham's (1946, 1954) definitions as they seem to be part of the generative hyphal system and are continuous with it. In this respect they do not resemble the thick-walled, nodose-septate, branching hyphae of the binding hyphal system seen in carpophores of *Lenzites betulina* and *Polyporus versicolor* in this group. These thick-walled, nodose-septate hyphae in the carpophores of *Lenzites betulina, Polyporus versicolor* and *Polyporus vinosus*, may be described as "sclerified generative hyphae" (Donk, 1964) with a binding function. Their presence in carpophores of *Polyporus vinosus* establishes a much more complex construction of these carpophores than in those of *Fomes pinicola*, which also has a dimitic hyphal system. This complexity of construction is not conveyed by the phrase, "carpophores with dimitic hyphal system" in the sense of Corner (1932 b, 1953), Cunningham (1946, 1954), Teixeira (1962 b) and Fidalgo & Fidalgo (1967).

From the descriptions it is clear that the structures found in the cultures of *Polyporus vinosus* are also present in the carpophores from which they were made. Fibre hyphae formed in culture were found to be much shorter than those of the carpophores. This appeared to be due to the very slow rate of growth of these hyphae in culture. In all other characters, the hyphae from these two sources were similar. No nodose-septate hyphae with pale-brown and slightly thickened walls were formed in the cultures although they were numerous in the carpophores. They may be expected to form in cultures under the right conditions since they were often seen to be continuous with the thin-walled nodose-septate hyphae in the carpophores.

When compared with other species of Group 45 described above, important differences in hyphal characters and carpophore construction are evident between their carpophores and those of *Polyporus vinosus*. The other species all have carpophores in which branched, aseptate, binding hyphae (Corner, 1932 a) bind the skeletal hyphae together. The presence or absence of different types of hyphae in carpophores is regarded by Teixeira (1962 b), Bondartseva (1961) and Fidalgo & Fidalgo (1966) as important at the generic level. Since branched, aseptate, binding hyphae (Corner 1932 a, b) are not present in the carpophores of *Polyporus vinosus*, this species cannot be regarded as congeneric with any genus in which such hyphae are present. For this reason Patouillard's (loc. cit.) transfer of this species to the genus *Coriolus* Quél., is untenable.

Imazeki (1952) transferred *Polyporus vinosus* to the genus *Fomitopsis* Karsten of which *Fomes pinicola* (Sw. ex Fr.) Cooke is the type species (Cooke, 1959). Carpophores of both these species have dimitic hyphal systems while their upper surfaces are covered by resinous or lacquer-like layers. In carpophores of *Polyporus vinosus* however, the fibre hyphae are dark-coloured and more closely interwoven than the hyaline fibre hyphae in carpophores of *Fomes pinicola*. Thin-walled, nodose-septate hyphae in carpophores of *Fomes pinicola* do not turn dark or develop thickened walls and bind the fibre hyphae in the tramal tissues as in carpophores of *Polyporus vinosus*. The carpophores of *Fomes pinicola* are thus simpler in construction than those of *Polyporus vinosus*. Furthermore, *Polyporus vinosus* has the tetrapolar type of interfertility and its cultures produced extra-cellular oxidase enzymes, whereas *Fomes pinicola* has the bipolar type of interfertility (Mounce, 1929) and its cultures lack extra-cellular oxidase. It appears therefore that *Polyporus vinosus* and *Fomes pinicola* cannot be regarded as being congeneric.

Murrill (1905) created the genus *Nigroporus* with *Polyporus vinosus* Berk. as the type and only species. In view of the above descriptions it appears that this genus may be retained for species with dark-coloured carpophores consisting of hyaline, thin-walled, nodose-septate hyphae, brown, thick-walled, nodose-septate hyphae and unbranched fibre hyphae with brown walls, hyaline, allantoid basidiospores and which cause a white rot of hardwoods. No other species possessing this combination of characters are known so that the relationships of this species are obscure at present.

Resumé.

The species included here in Group 45 have all those characters in common which are required for their inclusion in this group. On the basis of differences in the micromorphology of their carpophores however, three smaller sub-groups may be distinguished, viz.: (i) a sub-group in which the binding hyphal system consists of thick-walled, aseptate fibre hyphae with short, tortuous branches and branching, thick-walled or solid, nodose-septate hyphae and which includes *Polyporus versicolor*, *Trametes suaveolens*, *Lenzites betulina*, *Polyporus pubescens*, *Trametes meyenii* and *Lenzites palisoti;* (ii) a sub-group in which the binding hyphal system is composed of aseptate, thick-walled fibre hyphae with long flexuous tapering branches and which includes *Polyporus occidentalis* and *Trametes cingulata* and (iii) a sub-group without a binding hyphal system which includes *Polyporus vinosus*.

The species in these three sub-groups thus share a number of correlated characters, viz.: production of extra-cellular oxidase, association with white rots, nodose-septate hyphae, fibre hyphae and the tetrapolar type of interfertility. It appears that these species share a common ancestry but show diversity in the elements of their carpophores and in their construction.

5.8 Group 51

Cultures of species in this group form white to cream coloured mycelial mats which soon develop extensive, appressed, brown, pseudoparenchymatous areas. Extra-cellular oxidase enzymes are produced. Their thin-walled hyphae have simple clamps at the septa and may remain so or may develop thick-walled, irregular projections and cuticular cells in the pseudoparenchymatous areas. Thick-walled, aseptate fibre hyphae are also formed. Their basidiospores are cylindrical. Interfertility is of the tetrapolar type in those species of which this character is known.

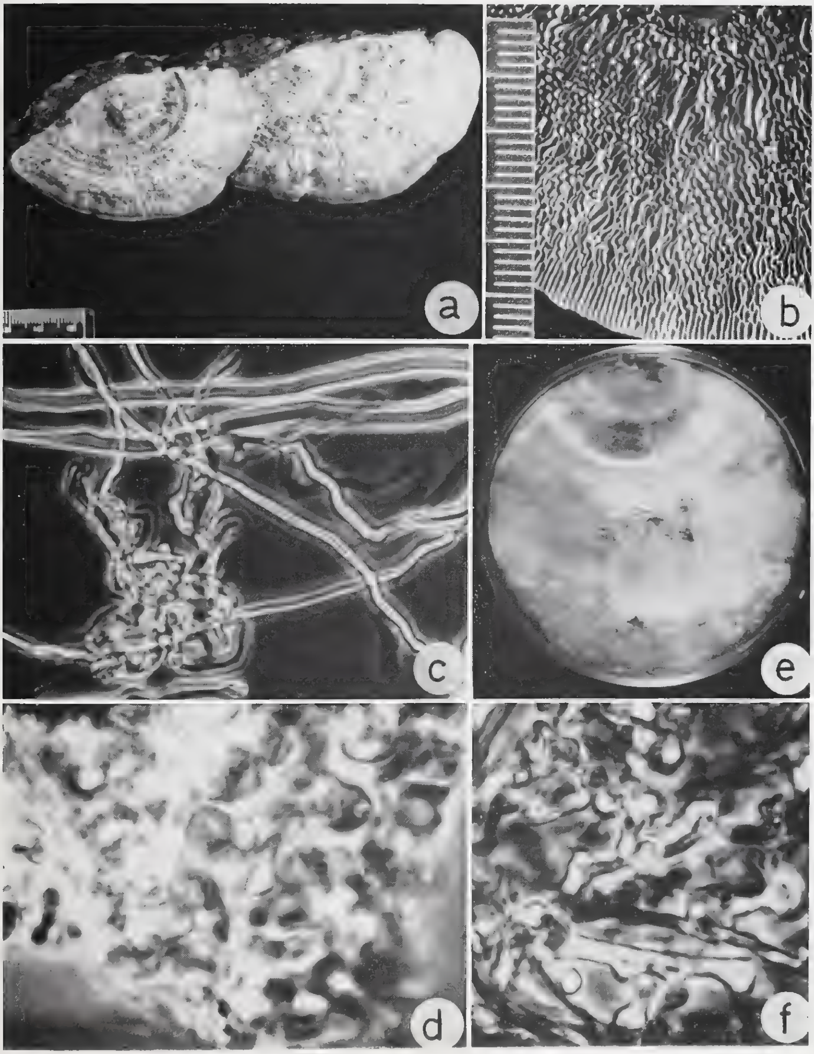

FIG. 39.— **Daedalea confragosa.** (a) Carpophores, upper surface, of PRE 42386 and (b) hymenial surface; (c) unbranched fibre hyphae and fibre hyphae with numerous branches from lower context, × 400 phase contrast; (d) cuticular cells from upper surface of DAOM 30121, × 1000, squash preparation; (e) culture of PRE 42345 at six weeks; (f) cuticular cells and hyphae with interlocking projections from culture, × 500 phase contrast.

Daedalea confragosa *Bolt. ex Fr.* in Syst. Myc. 1, 336, 1821;

Daedaleopsis confragosa (Bolt. ex Fr.) Schroet. in Cohn Kryptog.-Fl. Schles. Pilz. p. 493, 1888;

Trametes confragosa (Bolt. ex Fr.) Jörstad, Kgl. Norske Videnskab. Selskabs. 10, 28, 1936.

Cultural characters

Growth moderately fast to slow the mats attaining radii of 8 — 15 mm in one week and covering the plates in three to six weeks. Advancing zone even, closely appressed, hyaline or white becoming more raised and somewhat cottony to woolly towards the inoculum or remaining sub-felty and appressed with isolated felty patches. After about 2 weeks sunken areas of collapsed mycelium appear, bordering abruptly on the white aerial mycelium and on dark, crustose areas of "hazel", "russet", "avellaneous", "wood brown" to "army brown" colour which develop in some isolates. In others, the mat remains thin, sub-felty to sodden, with little or no aerial mycelium, developing patches of submerged mycelium, or, patches of raised, felty, aerial mycelium covered with irregular, crustose areas of "cinnamon buff", "Saccardo's umber" or "mummy brown" which gradually increase in size. White, aerial mycelium may darken gradually to "light buff", "light pinkish cinnamon" or "tawny". After six weeks the plates may be covered with thin, tough, felty mycelium, white in some parts or mostly in shades of brown varying from "light buff", "light pinkish cinnamon" to "avellaneous", "wood brown" or "cinnamon brown" and oozing droplets of dark brownish liquid, some covered by irregular, crustose areas of "natural brown" or "Mars brown", somewhat sunken and sharply demarcated from the felty mycelium. Or, the mat may be sub-felty and sodden with irregular, crustose areas with characteristic, sunken margins in "cinnamon brown" to "Saccardo's umber" along the margins, occasionally incompletely covered in their central parts. The reverse darkens gradually in reddish brown colours, mostly more deeply coloured under the crustose areas and presenting a marbled appearance. No odour is emitted by most isolates but a slight, pepper-like odour may be present in some.

On gallic acid and tannic acid agar strong diffusion zones are formed but no growth takes place on gallic acid and only a trace on tannic acid agar.

Advancing mycelium: hyphae hyaline, thin-walled, nodose-septate, branching at or near the septa often with numerous short branches from a short section of hyphae, 2.0 — 4.0μ in diameter (Fig. 40 a).

Aerial mycelium: (a) hyphae as in the advancing zone; (b) fibre hyphae hyaline at first, darkening later, branched, the branches long, tapering, solid or nearly so with the lumina narrow, aseptate or with one or two simple septa near the thin-walled tip, 1.5 — 3.0μ in diameter (Fig. 40 b); (c) cuticular cells ferruginous brown, thin-walled or thick-walled, of irregular shape, often distended into a number of irregular projections up to 20μ in diameter and arising from thin-walled,

Fig. 40.— **Daedalea confragosa.** a - d. Structures from cultures: (a) hyphae from advancing zone; (b) fibre hyphae; (c) cuticular cells; (d) nodose-septate hyphae with thick, brown walls and irregular projections.

e - q. Structures from carpophores: (e) thin-walled, branching, nodose-septate hyphae; (f) brown, thick-walled, nodose-septate hyphae; (g) unbranched, fibre hyphae; (h) fibre hyphae with branches towards the distal end; (k) fibre hyphae with numerous, short, tortuous branches; (m) thick-walled, nodose-septate hyphae with tortuous branches; (n) basidia; (p) basidiospores; (q) basidiole.

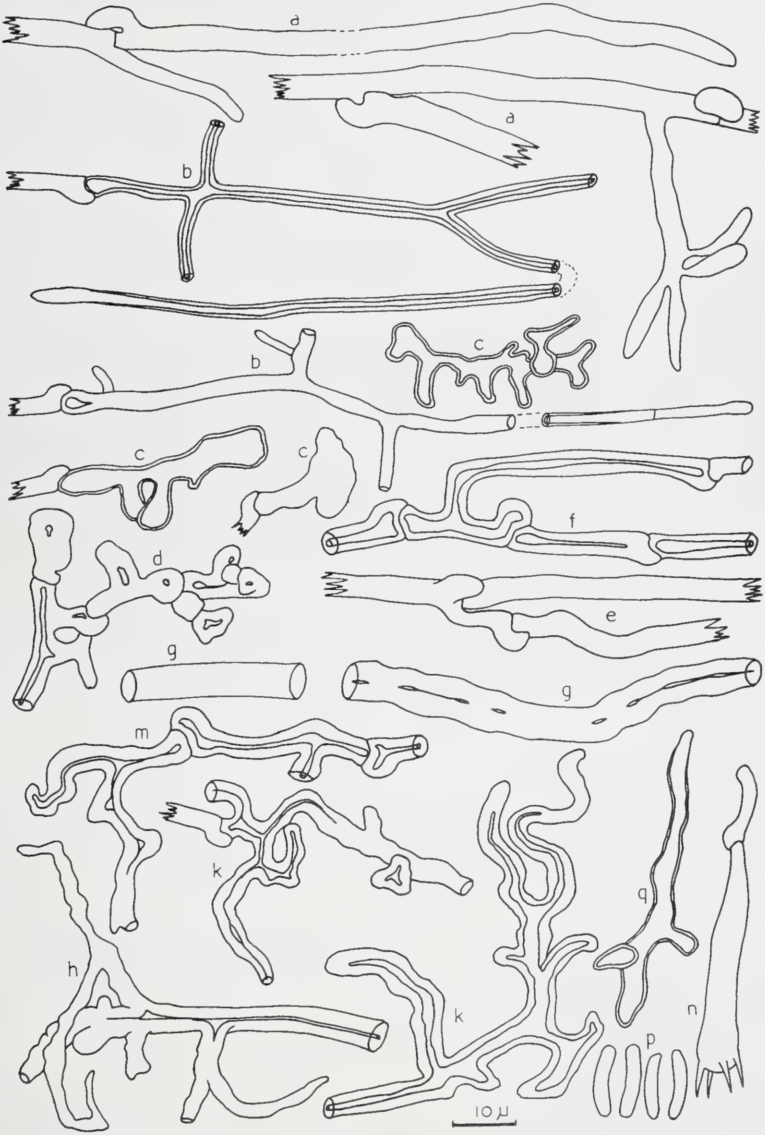

FIGURE 40.

nodose-septate hyphae, (Fig. 40 c) not present in all cultures; (d) nodose-septate hyphae with thickened brown walls, 2.0 — 4.5μ in diameter, branched, often with irregular projections and often agglutinated into strands, apparently intergrading into the cuticular cells and forming crustose areas (Fig. 40 d).
Submerged mycelium: hyphae as in the advancing zone.

Carpophore characters

Carpophore annual or reviving, lignicolous, solitary, sessile, dimidiate, applanate, plane to somewhat convex above, occasionally imbricate, or laterally connate; leathery and watery when fresh, drying to hard, rigid, woody, 2 — 10 x 3 — 15 x 0.2 — 3.0 cm; upper surface greyish, smoky, umber or sometimes with a reddish brown crust, finely pubescent to glabrous or nearly so, radiately rugose, often concentrically grooved; margin acute, thin; pore surface whitish to avellaneous drying to isabelline or pale brown, poroid to daedaloid or lamellate, pores 0.5 — 1.5 mm wide, dissepiments entire but often becoming lacerate or dentate; tubes concolorous 0.1 — 1.5 cm deep; context floccose to corky, whitish to pale brownish, zonate, 0.2 — 1.5 cm thick.

Hyphal characters. Carpophores consist of: (i) hyaline, thin-walled, nodose-septate hyphae branching close to the septa, 2.0 — 3.0μ in diameter (Fig. 40 e); (ii) nodose-septate hyphae with thickened walls and narrow or occluded lumina, the walls sub-hyaline or brownish and lumina empty or with deeply staining contents, 1.0 — 3.0μ in diameter (Fig. 40 f); (iii) fibre hyphae long, unbranched, straight or flexuous, smooth or somewhat uneven to almost moniliform towards the tapering ends, sub-hyaline to pale brown, the walls thick and lumina narrow or occluded to form a series of deeply staining dots along the moniliform parts, aseptate, widening only at the extremities, 3.0 — 9.0μ in diameter (Fig. 40 g); (iv) fibre hyphae, hyaline or sub-hyaline, flexuous or fairly straight, sub-solid to solid, aseptate, branching towards the distal end, the branches short tortuous and tapering towards their tips, 3.0 — 6.0μ in diameter (Fig. 40 h); (v) fibre hyphae with short, tortuous branches, sub-hyaline, thick-walled, lumina narrow or occluded, aseptate, 1.0 — 3.0μ in diameter (Fig. 40 k); (vi) nodose-septate hyphae thick-walled, sub-hyaline, with short, tortuous branches. 1.0 — 3.0μ in diameter (Fig. 40 m); (vii) cuticular cells brown, irregularly distended, often with irregular projections, thin-walled or thick-walled and occasionally with deeply staining contents, 8 — 12μ in diameter (Fig. 39 d).

Hymenium: basidia long, clavate, hyaline, 12.0 — 24.0 x 2.5 — 4.5μ, bearing 4 straight sterigmata 2.8 — 3.2μ in length (Fig. 40 m); basidiospores hyaline, long cylindrical to allantoid, smooth, thin-walled, 5.4 — 7.8 x 1.2 — 1.8μ (Fig. 40 p); basidioles sub-hyaline, thin-walled or walls slightly thickened, 28.0 — 36.0 x 1.5 — 3.0μ with one to four irregular, short, terminal branches up to 15.0 x 1.0 — 3.0μ (Fig. 40 q).

Construction. At the margin the fruit-body consists of long, unbranched fibre hyphae straight or somewhat flexuous and more or less parallel to each other, arising from thin-walled, branching, nodose-septate hyphae with deeply staining contents, intertwined with the fibre hyphae.

Behind the margin in the upper part of the context the tissues consist almost entirely of solid or sub-solid, faintly brownish, unbranched fibre hyphae arranged more or less parallel to one another, bending towards the upper surface where their tips, with slightly dilated lumina, end at a common level to form the finely pubescent upper surface. Interwoven with these fibre hyphae and running across their direction of growth are long flexuous or tortuous fibre hyphae binding the parallel hyphae into a firm tissue.

At the upper surface in the older parts the terminal portions of the fibre hyphae are closely intertwined and interwoven in all directions to form a cortex with a finely pubescent upper surface which soon becomes agglutinated into a thin, glabrous, cuticular layer by a hyaline lacquer-like substance. In this cortex narrow, hyaline, branching, thin-walled, nodose-septate hyphae 1.0 — 1.8μ in diameter and with deeply staining contents, are very numerous and interwoven with the fibre hyphae. On some fruit-bodies short, narrow, hyaline, solid hyphae grow upward from these nodose-septate hyphae and become lightly entangled and interwoven to form patches of pubescent tissues on the upper surface. Rarely, nodose-septate hyphae with pale brown walls may grow upwards from these thin-walled hyphae in the cortex and may develop irregular projections or become expanded into cuticular cells in some fruit-bodies. All these elements eventually become agglutinated together with fibre hyphae by a brown, amorphous, lacquer-like material into hard, crustose masses over the upper surfaces. The middle and lower context, consist of long fibre hyphae, fairly tightly packed, more or less parallel and bending downward towards the dissepiments. Just above the dissepiments the fibre hyphae become more tortuous especially towards their tips and many develop short, tortuous, lateral branches. In this region short, tortuous, fibre hyphae with many short, tortuous branches (binding hyphae, Corner, 1932 a) become very numerous and tightly interwoven with the other hyphae, binding them into a tough, homogeneous tissue. Also present in this region are narrow, branching, hyaline, thin-walled, nodose-septate hyphae with deeply staining contents interwoven with the fibre hyphae. The tissues of the dissepiments consist of tightly interwoven, branched, thick-walled, nodose-septate hyphae and fibre hyphae inextricably interwoven and narrow, thin-walled, nodose-septate hyphae branching repeatedly and ramifying among the fibre hyphae towards the hymenial surfaces where they bear the basidia in clusters on short branches.

Decay and hosts

Daedalea confragosa causes a white rot of dead sapwood of various hardwood trees but had been noticed on wounds as well (Overholts, 1953).

Specimens examined

Herb. DAOM: *F1577, on *Fagus grandifolia,* Meach Lake, Que.; F6307, on *Salix nigricotinifolia,* Ottawa, Ont., Nov. 1931; F6457, on *Betula alba* var *Papyrifera,* Cartier Lake, Petawawa, Ont., Aug. 1935; F7757, on *Betula* sp., Chalk Riv., Ont., Sept. 1937; F7763, on *Betula* sp., Chalk Riv., Ont., Sept. 1937; F8018, on *Betula* sp., Iberville, Que., Jan. 1938; F8063, on *Acer saccharum,* Petawawa, Ont., Aug. 1937; F8080, near Ludlow, Shropshire, Sept. 1937; F8340, on *Betula papyrifera,* Gatineau, Que., Aug. 1938; *F8997, on *Acer* sp., Ottawa, Ont.; F9111, on *Alnus incana,* Notakim Depot, Que., Sept. 1939; *F9210, on *Betula papyrifera,* Chelsea, Que., May 1939; F9411, on *Betula papyrifera,* Horseshoe Bay, Ont., Aug. 1939; F10783, on *Prunus avium,* Caledon East, Ont., Oct. 1941; *17555, on *Betula lutea,* Gatineau Park, Que., Sept. 1947; 22399, on *Betula occidentalis,* Kaslo, B.C., Aug. 1948; 22546, on *Salix bibbiana,* Steen River, Alberta, July 1950; 30121, on *Prunus* sp., Vancouver, B.C., 1948; 30269, on *Populus trichocarpa,* Kaslo, B.C., Oct. 1951; 30270, on dead *Salix* sp., Candle Lake, Sask., Aug. 1949; 31089, on *Salix bibbiana,* Riding Mountain, Man., May 1949; 52911, on *Betula* sp., Sicamous, B.C., Aug. 1912; 53773, on *Betula* sp., Esher, Surrey, Sept. 1959; 69975, on *Salix* sp., Agassiz, B.C., Sept. 1959; 72334, on *Betula papyrifera,* Petawawa, Ont., Sept. 1946; *94045, on dead yellow birch, Dorset, Ont., Sept. 1962; *94052, on dead hardwood branches, Dorset, Ont., Sept. 1962; *94054, on dead wood, Dorset, Ont., Sept. 1962.

Discussion

The cultural characters of *Daedalea confragosa* as described above, agree well with the requirements for its inclusion in Group 51. The description also agrees well with earlier descriptions by Davidson *et al.* (1938, 1942) and Nobles (1948, 1965).

Cultures of *Daedalea confragosa* develop dark-coloured, skin-like or crustose areas which are formed in cultures of species of stipitate polypores as described by Nobles (1958 b) in Group 53. Nobles (1948) stated that cultures of *Daedalea confragosa* may be confused with those of *Polyporus tuberaster* and *Polyporus brumalis* but that cultures of these stipitate species may be distinguished from those of *Daedalea confragosa* by having more extensive pseudoparenchymatous areas. The presence of cuticular cells, which are frequently found in cultures of *Daedalea confragosa* but not in those of *Polyporus tuberaster* and *Polyporus brumalis*, appears to be an aditional diagnostic character. Furthermore, cultures of *Daedalea confragosa* tend to have brownish compact, tough, felty or sub-felty mycelial mats while those of *Polyporus brumalis* and other stipitate species in Group 53 (Nobles, 1958 b) mostly possess white, woolly, aerial mycelium around the pseudo-parenchymatous areas. The distinctions together with consideration of host records may serve to distinguish cultures of *Daedalea confragosa* from those of the other two species.

The carpophores of *Daedalea confragosa* consist of five different types of hyphae, viz. nodose-septate hyphae, which may be thin-walled generative hyphae, or, thick-walled hyphae with tortuous branches which form part of the binding hyphal system, unbranched fibre hyphae or skeletal hyphae (sensu Corner, 1932 a), fibre hyphae with flexuous branches towards the distal ends, which also contribute to the binding hyphal system, and fibre hyphae with numerous short, tortuous branches (binding hyphae, sensu Corner, 1932 a, 1953). Since generative, skeletal and binding hyphae are present in the fruit-bodies, these fruit-bodies have a trimitic hyphal system (sensu Corner, 1932 a; Cunningham, 1946); but morphologically and ontogenically different hyphae comprise the binding hyphal system of the fruit-bodies.

Cuticular cells and brown, thick-walled nodose-septate hyphae with irregular projections were present on the upper surfaces of a very small proportion of the fruit-bodies examined. These structures arise as modified terminal parts of the thin-walled, nodose-septate hyphae present near the upper surfaces of the fruit-bodies. Numerous narrow, thin-walled, nodose-septate hyphae were present at the upper surfaces of all the fruit-bodies examined. It therefore appears that the growth and modification of these hyphae into cuticular cells, occur in nature under certain conditions only.

From the descriptions it is evident that structures formed in cultures of *Daedalea confragosa* may also be present in the carpophores from which they were made; but some differences in morphology are evident in certain structures. The fibre hyphae formed in culture are of one type only being narrow and branched with the branches long, narrow and tapering. These fibre hyphae differ in their manner of branching from the fibre hyphae present in the carpophores of *Daedalea confragosa* and appear to be intermediate between the unbranched and much-branched fibre hyphae of the fruit-bodies. Cuticular cells were not formed in all the cultures examined but thick-walled hyphae with irregular projections were mostly present. These structures developed even in cultures made from sporophores from which they were absent. It thus appears that the development of these structures depends on the conditions under which the mycelium is growing rather than its genetic complement. Conditions favourable for their development thus appear to exist more frequently in culture than in nature. Their presence in carpophores thus represents a character of doubtful taxonomic value.

The hyphal characters and construction of carpophores of *Daedalea confragosa* had been described before by different workers. Cunningham (1948 h) included the genus *Daedaleopsis* Schroet., of which *Daedalea confragosa* is the type species

(Donk, 1960), in the genus *Daedalea* Pers. ex Fr., which he characterized as having a trimitic hyphal system with skeletal hyphae unbranched, aseptate, some shade of brown; binding hyphae aseptate, commonly of the bovista type, some shade of brown and nodose-septate, hyaline, generative hyphae. Overholts (1953) reported that the hyphae of *Daedalea confragosa* were mostly simple, aseptate and thick-walled while some narrow hyphae were branched to form "a simple type of hyphal complex". Teston (1953 b) also reported nodose-septate generative and unbranched, thick-walled, skeletal hyphae in fruit-bodies of *Trametes erubescens* Alb. & Schw. ex Fr. (= *Daedalea confragosa* Bolt. ex Fr.), with much-branched, sinuous, thick-walled binding hyphae also present in the trama of the tubes. The hyphal characters and construction of the fruit-bodies of *Daedalea confragosa* as described above thus agree with reports by earlier workers but more detail is presented here.

Comparison of the above descriptions with those of the type species of other genera to which *Daedalea confragosa* had been assigned by earlier workers, reveals important differences. Fries (1821) placed this species in the genus *Daedalea* Pers. ex Fr. and was followed in this by many later workers (Pilát, 1936); but in cultures and carpophores of *Daedalea quercina* L. ex Fr., the type of the genus *Daedalea* Pers. ex Fr., nodose-septate hyphae with irregularly thickened walls are present. Its cultures do not produce extra-cellular oxidase and its carpophores lack binding hyphae. Nodose-septate hyphae with irregularly thickened walls are absent from the cultures and carpophores of *Daedalea confragosa*. Instead, cuticular cells and hyphae with irregular projections are present. Furthermore, cultures of *Daedalea confragosa* produce extra-cellular oxidase and binding hyphae are present in its carpophores. *Daedalea confragosa* thus cannot be regarded to be congeneric with *Daedalea quercina* despite many superficial similarities.

Ames (1913), in her study of the structure of polypore fruit-bodies, included *Daedalea confragosa* in the genus *Daedalea* Fr. of which she stated, "This genus differs from *Trametes* only in the form of the hymenial surface". She found no difference in the structure of different species in these two genera. Later, Jörstad (loc. cit.) transferred *Daedalea confragosa* to the genus *Trametes* Fr. and comparison with *Trametes suaveolens* (L. ex Fr.) Fr., the type species of that genus, reveals many similarities. The general plan of construction of the carpophores is similar in both species. Binding hyphae are numerous in the lower context and rare in the upper context of carpophores of both species. Unbranched fibre hyphae are more closely packed in the carpophores of *Daedalea confragosa* resulting in a corky texture of the fruit-bodies while those of *Trametes suaveolens* are loosely packed to form the soft, spongy tissue of carpophores of this species. The same types of hyphae occur in carpophores of both species but the cuticular cells and hyphae with irregular projections are never formed in carpophores of *Trametes suaveolens* of which the upper surfaces never become crustose. Also, the binding hyphae of *Trametes suaveolens* are more translucent than those of *Daedalea confragosa* which resemble the unbranched fibre hyphae. The basidiospores of *Daedalea confragosa* are allantoid in shape unlike the cylindrical spores of *Trametes suaveolens*. In cultural characters the differences between the two species are much more striking because of the presence of brown, skin-like or crustose areas and their associated modified hyphal elements are never found in carpophores or cultures of *Trametes suaveolens* so that their presence in those of *Daedalea confragosa* constitute a genetic difference between the two species. Because the absence or presence of different types of hyphae are considered to be of importance at the generic level (Bondartseva, 1961; Teixeira, 1962 b) and because of the differences in cultural and carpophore characters, these two species do not appear to be congeneric despite the presence of many similar characters.

Daedalea confragosa had also been referred to the genus *Lenzites* Fr. by various workers (Pilát, 1936). Many similarities in hyphal characters and construction exist between fruit-bodies of *Daedalea confragosa* and *Lenzites betulina* (L. ex Fr.) Fr. the type of the genus *Lenzites* Fr.; but *Daedalea confragosa* differs from *Lenzites betulina* in the same characters in which it differs from *Trametes suaveolens* so that these two species cannot be considered to be congeneric.

Because of these differences it seems best to maintain *Daedalea confragosa* in the genus *Daedaleopsis* Schroet. of which it is the type species (Donk, 1960). Future studies, however, may well reveal transitional species to the genus *Trametes* with which *Daedalea confragosa* has strong affinities.

Trametes corrugata *(Pers.) Bresadola* in Hedwigia 51, 316, 1912;

Polyporus corrugatus Pers. in Gaudichaud, Voy. Freyc. Uranie Bot. 172, 1827;

Earliella corrugata (Pers.) Murill in Bull. Torrey Bot. Club 34, 468, 1907;

Coriolus corrugatus (Pers.) G. H. Cunningham in Proc. Linn. Soc. N.S.W. 75, 222, 1950;

Formitopsis corrugata (Pers.) Imazeki in Bull. Tokyo Sci. Mus. 6, 92, 1943.

Cultural characters

Growth is moderately rapid the mat reaching a radius of 25 mm in one week and covering the plate in 3 — 4 weeks. The margin is even, mycelium appressed or submerged for a short distance, then raised, floccose-woolly, pure white at first but becoming somewhat collapsed, more woolly to felty with faint, brownish colours developing in spots on the felty mycelium, after two weeks. The mat gradually becomes more dense with balls of woolly, white mycelium forming on its surface and on the sides of the dish. One or two concentric, sulcate zones appear over the cultures and within two to three weeks crustose areas, at first smooth and "hazel" or "cinnamon", appear and increase in size, their margins contrasting sharply with the white, woolly mat. Crustose areas remain "hazel" or "cinnamon" or become "cinnamon rufous" or "cinnamon brown" and roughened, somewhat papillate and rugose in the older parts. Shiny, smooth, "cinnamon rufous" or "cinnamon brown" laccate areas form in the crustose areas against the glass sides of the dish. After four to five weeks lumps of woolly mycelium may form against the sides of the dishes and gradually develop waxy or pasty, slightly sunken areas on which low, labyrinthiform lamellae, from which spores are discharged in inverted cultures, are formed. The reverse bleaches after two weeks and a faint mushroomy odour is given off. A strong positive reaction is obtained when the culture is tested for extra-cellular oxidase by means of gum guaiac solution. Strong diffusion zones are formed on gallic acid and tannic acid media with colonies reaching up to 15 mm in diameter on tannic acid agar after one week.

Advancing mycelium: hyphae hyaline, branching, nodose-septate, thin-walled, 2.2 — 4.5μ in diameter (Fig. 42 a).

Aerial mycelium: (a) hyphae as in the advancing zone; (b) fibre hyphae hyaline, straight, unbranched or occasionally branched, thick-walled, the lumina narrow, aseptate, 1.5 — 3.5μ in diameter (Fig. 42 b); (c) narrow hyphae repeatedly dichotomously branched, hyaline 0.7 — 1.5μ in diameter, forming a net-like structure just above the agar (Fig. 42 c); (d) hyphae with brown, thickened walls

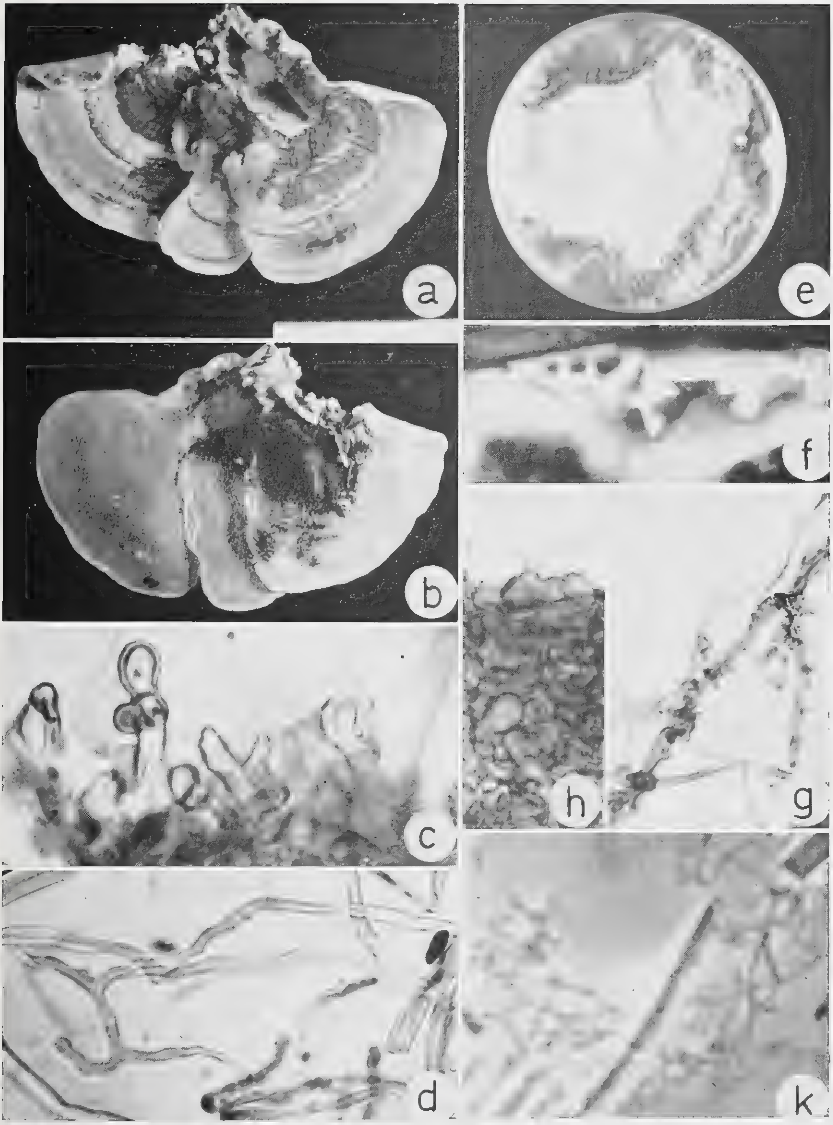

Fig. 41.—**Trametes corrugata.** (a) Upper surface and (b) hymenial surface of carpophore of PRE 34446; (c) cuticular cells from red stain on upper surface of carpophore of type specimen of *Earliella cubensis*, × 1000; (d) unbranched fibre hyphae and fibre hyphae with numerous branches from context of type specimen of *Earliella cubensis*, × 500; (e) culture of PRE 42454 at six weeks; (f) fructification in culture; (g) nodose-septate hyphae with irregular projections from culture, × 100; (h) cuticular cells from culture, × 100; (k) narrow, hyaline, branching hyphae from culture, × 1000.

bearing short lateral projections up to 7μ long, walls thickened to sub-solid or solid, 2.5 — 3.5μ in diameter and arising from nodose-septate hyphae (Fig. 42 d); (e) cuticular cells pale brown, sub-globose to ovoid or irregular in shape with fairly thin walls up to 25μ in diameter and arising from thin-walled pale or hyaline nodose-septate hyphae, and often embedded in a brown lacquer-like substance (Fig. 42 e).

Fructification: basidia cylindrical or narrowly clavate, 22.5 — 34.0 x 5.2 — 6.7μ, bearing four straight sterigmata 5.2 — 6.0μ (Fig. 42 f); basidiospores hyaline, smooth, thin-walled, long-elliptical to cylindrical, 6.7 — 10.5 x 3.7 — 5.2μ (Fig. 42 g).

Submerged mycelium: hyphae as in the advancing zone.

Carpophore characters

Carpophore annual, lignicolous, sessile, effused-reflexed, laterally extended, or conchate, connate, occasionally imbricate, woody, up to 15 x 3 — 6 x 0.2 — 2.5 cm; surface at first smooth, finely pubescent to glabrous. becoming rugose, zonate in older parts, creamy to "light buff" and thinly encrusted in "cinnamon brown" to dark "liver brown" or almost black areas in the oldest parts; margin obtuse at first, thick, later thin, creamy white, undulate, drying to "light buff"; pore surface pale pinkish when fresh drying to creamy white or "light buff", pores 2 — 4 per mm, poroid to daedaloid, rounded; dissepiments even, thick at first, later thin; tubes 1 — 8 mm deep; context white, corky to fibrous, zonate, drying to "light buff", 2 — 20 mm thick.

Hyphal characters. Carpophores consist of (i) hyaline, branching, thin-walled, nodose-septate, hyphae, 1.5 — 3.5μ in diameter (Fig. 42 h); (ii) fibre hyphae hyaline, straight or tortuous, unbranched or with an occasional long branch, the walls thickened, lumina prominent or narrow or occluded, aseptate or occasionally with one or two simple septa near the apex, 2.5 — 5.0μ in diameter (Fig. 42 k); (iii) fibre hyphae hyaline, sub-solid, repeatedly branched, the branches short or fairly long, flexuous, 2.5 — 3.5μ in diameter (Fig. 41 d, 42 m); (iv) narrow, hyaline, sub-solid hyphae, repeatedly branched, 0.5 — 0.7μ in diameter (Fig. 41 k); (v) cuticular cells with thickened, brownish walls distended into irregular shapes, 4.0 — 10.0μ in the widest parts and borne on thin-walled, nodose-septate hyphae (Fig. 41 c); (vi) nodose-septate hyphae with brownish thickened walls with irregular projections, 2.5 — 3.5μ in diameter (Fig. 41 c).

Hymenium: basidia hyaline, long, clavate 18.0 — 34.0 x 6.0 — 7.5μ and bearing four prominent sterigmata 4.5 — 6.0μ (Fig. 42 n); basidiospores hyaline, long cylindrical, smooth, thin-walled, obliquely apiculate, 8.0 — 12.0 x 4.5 — 5.5μ (Fig. 42 p).

Construction. At the margin the carpophore consists of long, more or less straight, fibre hyphae with thick, hyaline walls often thin-walled, and collapsed towards the extremities with lumina narrow, aseptate or with one or two simple septa, tightly intertwined with one another and with the branching, thin-walled, hyaline, nodose-septate hyphae from which they arise. Behind the margin the context consists of straight and tortuous, unbranched, fibre hyphae with hyaline walls partly thickened or sub-solid, and tightly intertwined. Nodose-septate hyphae, mostly empty, thin-walled and sometimes collapsed, are present in small numbers intertwined with the fibre hyphae. Interwoven with these hyphae are numerous hyaline, branching fibre hyphae, their branches long and tortuous, which bind all the hyphae into a tough, dense tissue. In the upper part of the context the fibre hyphae turn towards the upper surface where their ends are packed at a common level to

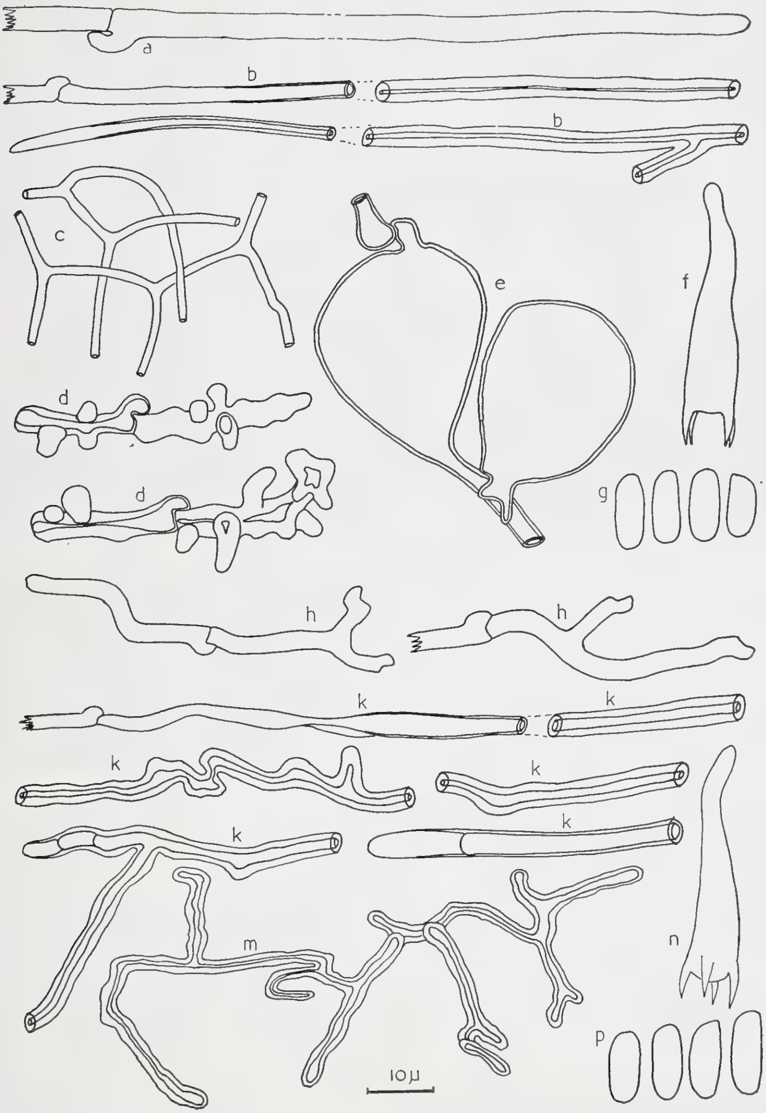

FIGURE 42.

FIG. 42.—**Trametes corrugata.** a - g. Structures from cultures: (a) hypha from advancing zone; (b) fibre hyphae; (c) narrow, dichotomously branching hyphae; (d) hyphae with brown, thickened walls and irregular projections; (e) cuticular cells; (f) basidium; (g) basidiospores.
h - p. Structures from carpophores: (h) thin-walled, nodose-septate hyphae: (k) fibre hyphae, unbranched or with occasional long branch; (m) fibre hypha with many short, flexuous branches; (n) basidium; (p) basidiospores.

from the finely pubescent upper surface not covered by the deep, reddish-brown, crustose structure. At the upper surface below the dark-coloured, crustose areas, numerous thin-walled, nodose-septate hyphae, mostly narrow and frequently branched are present, intertwined with the ends of the fibre hyphae and forming a thin-walled, pseudoparenchymatous layer up to about 50μ thick over the ends of the fibre hyphae. Immediately above this layer are larger cuticular cells and nodose-septate hyphae with interlocking projections on their thickened brown walls. These structures are agglutinated by a pale brown lacquer-like substance into the hard crust in a layer up to 150μ thick over the older part of the upper surfaces of the fruit-bodies. In the older parts of the context of some of the sporophores examined a delicate network of very narrow, hyaline, repeatedly branched hyphae was visible, interwoven with the wider hyphae. Their origin could not be determined (Fig. 41 k).

In the lower context the fibre hyphae turn downwards towards the dissepiments. They are narrow and with more prominent lumina than in the upper context. The long fibre hyphae become more tortuous and are tightly interwoven with branching "binding hyphae", some with solid clamps, which bind them into a tough, dense tissue. Thin-walled, nodose-septate hyphae become more numerous in the trama and dissepiments where they branch repeatedly, the branches ramifying between the fibre hyphae in the direction of the pore surfaces. At the pore surfaces the nodose-septate hyphae form numerous, very short branches on which the basidia are borne.

Decay and hosts

Trametes corrugata causes a white rot of hardwood logs in sub-tropical areas.

Specimens examined

Herb. PRE: 15623, on living *Albizzia* sp., Durban, Natal, March 1917; 28968, on dead wood, Rooikoppies Plantation, Duiwelskloof, Transvaal, May 1937; 30230, indigenous wood, Krantzkop, Natal, December 1935; 31684, indigenous wood, Ifafa, Natal, August 1916; 34446, rotting logs of Kukin trees, Hawaii, July 1930; 31736, on dry branch, Chinizina, Beira, Moçambique, April 1957; *42454, on decaying lidchi stem, Tzaneen, Transvaal, January 1961.

Herb. NY: *Earliella cubensis* Murrill, on dead wood, Herradura, Pinar del Rio Province, Cuba, March 7 — 12, 1905, (TYPE).

Interfertility studies

In order to determine the type of heterothallism present in *Trametes corrugata*, 16 mycelia, each obtained from a single basidiospore produced from a small fruit-body formed in culture, were paired in all possible combinations. The formation of clamp connections on the paired mycelia took place in a manner which proved that *Trametes corrugata* has the tetrapolar type of interferitility. The distribution of mating types among the single spore mycelia is given in Table 11 in the abbreviated form used by Yen (1950).

Discussion

The presence of cuticular cells, fibre hyphae and nodose-septate hyphae, in cultures which produce extra-cellular oxidase enzymes, places *Trametes corrugata*, which had not been described in culture before, in Group 51. Its cultural characters agree in many respects with those of other species in this group but cultures of *Trametes corrugata* may be recognized by the reddish colours of the crustose areas which contrast sharply with the pure white, woolly mycelium, and the very large, thin-walled, cuticular cells present in these crustose areas.

The carpophores of *Trametes corrugata* agree in construction and hyphal characters with those of other species in this group and consist of six types of hyphae. Of these, the cuticular cells and thick-walled hyphae with irregular projections are modified portions of the thin-walled, nodose-septate hyphae but because of the presence of clamp connections in them, they must be regarded as generative hyphae sensu Corner (1953) and Cunningham (1946). The unbranched fibre hyphae and fibre hyphae with many long, tortuous branches agree with Corner's (1932 a) and Cunningham's (1946) definitions of skeletal and binding hyphae respectively. The very narrow, branched, aseptate hyphae present in some carpophores appear to serve a binding function and may be regarded as part of the binding system although their origin and true nature could not be determined. Carpophores of *Trametes corrugata* thus have a trimitic hyphal system sensu Corner (1932 a) but hyphae which differ in morphology and ontogeny are present in the generative and binding systems. The trimitic hyphal system in carpophores of this species was also reported by Fidalgo & Fidalgo (1966).

The very narrow, branched hyphae were not present in all the carpophores examined. They were present in the context of the carpophores of PRE 42454 and in the trama of the pores of the type specimen of *Earliella* Murr., but they are visible only after prolonged and extremely careful search of the carpophore tissues. It appears that they become very brittle on drying and disintegrate when tissues from old specimens are teased out for examination. Similar hyphae had been noted in cultures of this and other species but have not been found in their carpophore tissues.

Although very large, thin-walled cuticular cells were present in the crustose areas of the cultures, the dark reddish-brown, crustose areas of the fruit-bodies of *Trametes corrugata* were found to consist almost entirely of small, distorted cells with thickened, brownish walls which closely resemble the hyphae with interlocking projections, present in the cultures. It was, however, found in the cultures that some of these projections on the brown, thick-walled hyphae were distended into thin-walled vesicles resembling small cuticular cells. It thus appears that cuticular cells and hyphae with interlocking projections are different structures that develop from the same hyphae probably under different conditions. If this is correct, then the hyphae with interlocking projections found in the carpophores must be regarded as homologous structures to the cuticular cells formed in cultures. All the structures formed in cultures are thus present in the carpophores from which they were made.

Although *Trametes corrugata* fits well into Group 51 in cultural characters, its fruit-bodies differ in hyphal characters from those of other species in this group. In the fruit-bodies of *Daedalea confragosa, Hexagona tenuis* and *Fomes fomentarius,* the long, unbranched fibre hyphae (skeletal hyphae, Corner 1932 a) are readily distinguishable from the tortuous, much-branched fibre hyphae (binding hyphae, Corner 1932 a). In fruit-bodies of *Trametes corrugata*, the binding hyphae mostly have long branches which are usually narrower and more tortuous than the unbranched hyphae in the upper context and may be recognized by their smaller diameter, branching and more tortuous appearance; but in the lower context where the skeletal hyphae are narrower and more tortuous than in the upper context, the two types of hyphae are very similar and portions of the branched hyphae are often indistinguishable from flexuous portions of the unbranched hyphae. Furthermore the fibre hyphae of *Trametes corrugata* are consistently hyaline under the microscope while those of *Daedalea confragosa, Hexagona tenuis* and *Fomes fomentarius* (Teixeira, 1962 b) are sub-hyaline to pale brown. The hyphal characters of *Trametes corrugata* thus differ from those

of *Daedalea confragosa*, *Hexagona tenuis* and *Fomes fomentarius*, and *Trametes corrugata* cannot, because of these differences as well as other differences in carpophore morphology, be considered to be congeneric with these species.

Imazeki (1943) placed *Trametes corrugata* in the genus *Fomitopsis* Karst. but comparison with the cultural characters and micromorphological characters of the carpophores of the type species, *Fomes pinicola* (Sw. ex Fr.) Cooke, shows this transfer to be untenable. The hyphal characters and construction of the context and crusts of the carpophores of the two species are completely different. Furthermore, extra-cellular oxidase enzymes are produced by cultures of *Trametes corrugata* but not by those of *Fomes pinicola*. The latter species has the bipolar type of interfertility (Mounce & Macrae, 1938) whilst *Trametes corrugata* has the tetrapolar type of interfertility.

Cunningham (loc. cit.) transferred *Trametes corrugata* to the genus *Coriolus* Quél. thereby implying similarity in hyphal characters and carpophore construction between this species and *Polyporus versicolor;* but from the above descriptions it is clear that *Trametes corrugata* differs from *Polyporus versicolor* in respect of the morphology of the binding hyphae in their carpophores. Furthermore, the hyphae with irregular projections, present in the crustose areas of carpophores of *Trametes corrugata*, are absent from those of *Polyporus versicolor* although somewhat similar structures have been found in its cultures. Because the absence or presence of different types of hyphae in carpophores is regarded as significant at the generic level by various workers (Teixeira, 1962 b; Donk, 1964; Fidalgo & Fidalgo, 1966) it appears that *Trametes corrugata* cannot be regarded as being congeneric with *Polyporus versicolor* L. ex. Fr., the type species of the genus *Coriolus* Quél. *Trametes corrugata* also differs from *Trametes suaveolens* in the same characters in which it differs from *Polyporus versicolor* so that Bresadola's (loc. cit.) combination also appears to be untenable.

The long, branched binding hyphae of *Trametes corrugata* resemble those of carpophores of *Trametes cingulata*. Other hyphal characters and the construction of the carpophores of these two species are also similar but hyphae with irregular projections and cuticular cells are absent from carpophores and cultures of *Trametes cingulata*.

Carpophores and cultures of *Trametes corrugata* differ in respect of hyphal morphology from some other species in Group 51 and from the type species of the genera *Coriolus* Quél., *Fomitopsis* Karst. and *Trametes* Fr. to which it had been referred by various workers. The presence of cuticular cells and hyphae with irregular projections and trimitic hyphal system in its carpophores, indicate affinities with the type species of the genera *Daedaleopsis* on the one hand and *Coriolus* and *Trametes* on the other. If the construction of the carpophores of *Daedalea confragosa*, *Fomes fomentarius*, *Hexagona tenuis*, *Trametes acupunctata* and *Trametes corrugata* is considered, however, it becomes evident that the presence of cuticular cells and hyphae with irregular projections in their carpophores is the main character common to them all while differences in the hyphal characters and construction of their carpophores exist.

It thus appears that these species may have acquired this character by convergent evolution and that their phylogenetic relationships are less intimate than the presence of cuticular cells and hyphae with inter-locking projections in their cultures and carpophores imply.

The general morphology of the carpophores of *Trametes corrugata*, their hyphal characters, construction, texture and spore characters agree with those of some species included in Group 45 (e.g. *Trametes cingulata*, *Trametes meyenii)*.

It thus appears that this species has strong affinities with others in that group; but the hyphal characters and construction of the carpophores of a larger number of species in both Group 45 and Group 51 will have to be examined before any definite conclusions can be reached, and the validity of the genus *Earliella* Murrill, of which *Trametes corrugata* (Pers.) Bres. (= *Earliella cubensis* Murr.) is the type species (Murrill, 1907 a), be established or rejected.

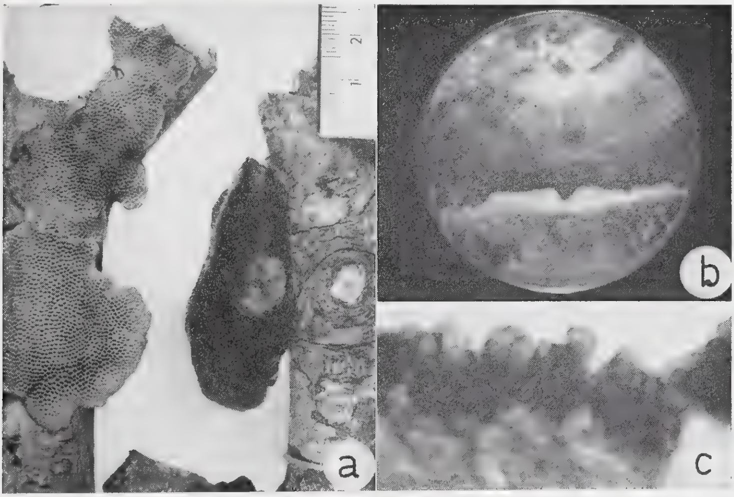

Fig. 43.—**Hexagona tenuis.** (a) Carpophores of PRE 43116; (b) culture of PRE 42159 at six weeks; (c) cuticular cells in red stain on upper surface of carpophore, × 500.

Hexagona tenuis *Hooker ex Fr.*, Epicr. Syst. Mycol., 498, 1838;

Daedaleopsis tenuis (Hooker ex Fr.) Imazeki in Bull. Tokyo Sci. Mus., 6, 78, 1943.

Cultural characters

Growth is moderately rapid, the mat covering the plate in 3 — 4 weeks. The advancing zone is bayed or even with hyphae raised to the limit of growth, the young mat thin, downy to floccose-cottony. Towards the inoculum the mat becomes more dense, woolly, white, radially sulcate, and, at about 10 — 20 mm around the inoculum, sunken and compacted into thin, appressed, pellicular, crustose areas of "cinnamon brown" to "wood brown" often with a thin, downy overgrowth of white mycelium after 2 — 3 weeks. With advancing age the white mycelium becomes increasingly woolly and dense, gradually becoming compacted into leathery, skin-like, wrinkled, crustose areas with colours ranging from "light ochraceous buff" to "tawny" to "russet," "natal brown" and patches of "mummy brown," irregular in outline and extending gradually until most of the surface is covered at six weeks. The reverse darkens with age, dark brown patches developing under the crustose areas often traversed by very dark, irregular lines and presenting a marbled appearance. A faint mushroomy odour is given off after two to three weeks but disappears later. A positive reaction is obtained when cultures are

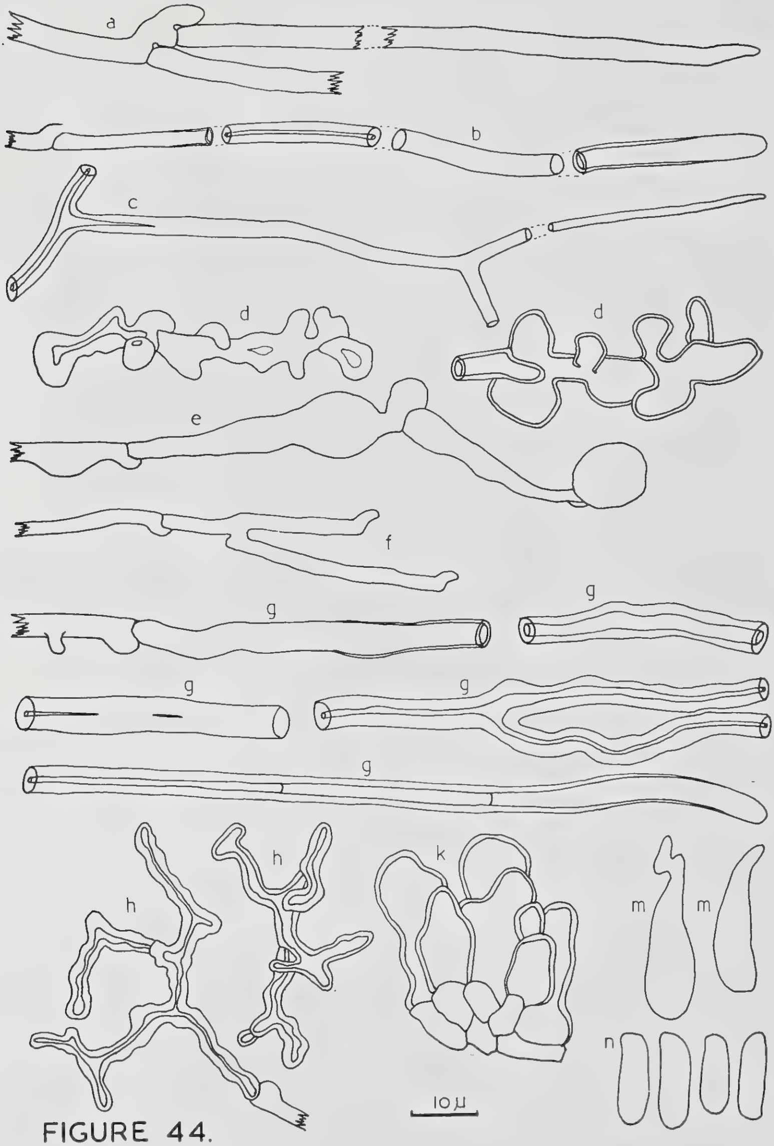

FIGURE 44.

FIG. 44.—**Hexagona tenuis.** a - e. Structures from cultures: (a) hypha from advancing zone; (b) unbranched, fibre hypha; (c) fibre hyphae with long tapering branches; (d) nodose-septate hyphae with irregular projections and cuticular cells; (e) swellings on hypha from submerged mycelium.
f - n. Structures from carpophores: (f) thin-walled, nodose-septate hyphae; (g) fibre hyphae, unbranched or occasionally branched; (h) fibre hyphae with numerous tortuous branches; (k) cuticular cells; (m) basidia; (n) basidiospores.

tested for extra-cellular oxidase by means of alcoholic gum guaiac solution. On gallic acid and tannic acid media, strong diffusion zones were formed but no growth occurred.

Advancing mycelium: hyphae hyaline, branching or simple, thin-walled, nodose-septate, with simple clamps and staining in phloxine, 2.2 — 3.7μ in diameter (Fig. 44 a).

hyaline to pale brown, walls thickened and lumina narrow or occluded, aseptate, 2.2 — 3.5μ in diameter (Fig 44 b); (c) fibre hyphae with long tapering branches, hyaline or pale brown, walls thickened, lumina aseptate, narrow or occluded or hyphae solid, .2 — 3.0μ in diameter (Fig. 44 c); (d) nodose-septate hyphae with walls slightly thickened, pale brownish to reddish brown and distorted into irregular projections and swellings or cuticular cells up to 15μ in diameter, tightly packed to form the dark-coloured, crustose areas (Fig. 44 d).

Submerged mycelium: hyphae as in the advancing zone and often developing swellings resembling the cuticular cells (Fig. 44 e).

Carpophore characters

Pileus annual, lignicolous, solitary, sessile, effused-reflexed, occasionally resupinate, applanate, conchate or flabelliform, free or laterally connate, coriaceous, 3.5 — 7.0 x 2.0 — 4.5 x 0.05 — 2 cm; surface glabrous, radially sulcate, rugose or smooth, "snuff brown" or "cinnamon brown" to "hazel" or "chestnut brown" often with dark "blackish brown" to "seal brown" areas towards the base; margin thin, acute, entire or rarely lobate, often undulate, "snuff brown," "cinnamon brown" to "hazel" or "chestnut brown"; pore surface "buckthorn brown" to "cinnamon brown," poroid; pores large, angular, 0.5 — 1 mm in diameter; dissepiments thin, even; tubes shallow, 0.5 — 1 mm deep; context rusty brown, darkening in KOH, fibrous, up to 1 mm thick.

Hyphal characters. Carpophores consist of: (i) hyaline, branching, thin-walled, nodose-septate hyphae with staining contents, 1.5 — 3.0μ in diameter (Fig. 44 f); (ii) fibre hyphae long, more or less straight or flexuous, unbranched or occasionally branched, the branches few, long, sub-hyaline to yellowish brown, the walls thickened or solid, lumina narrow or occluded widening at the extremities, aseptate or with one or two simple septa near the tip 3.0 —6.0μ in diameter (Fig. 44g); (iii) fibre hyphae hyaline to sub-hyaline, very tortuous, branching repeatedly over short distances, the branches short, tortuous, thick-walled, lumina narrow or occluded widening at the hyphal tips, aseptate, 1.0 — 3.0μ in diameter (Fig. 44 h); (iv) cuticular cells subglose to clavate with irregular, lobate projections, dark reddish-brown, thin-walled 5 — 15μ in diameter, arising from thin-walled, nodose-septate hyphae (Fig. 43 c, 44 k).

Hymenium: basidia hyaline, long clavate, almost cylindrical, 15.0 — 24.0 x 3.0 — 4.5μ with four slender, straight sterigmata 2.8 — 3.2u (Fig. 44 m); basidiospores hyaline cylindrical smooth, thin-walled 10.0 — 15.0 x 4.0 — 6.0μ (Fig. 44 n).

Construction. At the margin the carpophore consists of long, straight, unbranched, pale-brown fibre hyphae with prominent lumina, arranged parallel to the direction of growth and slightly intertwined with one another and with the hyaline, thin-walled, branching, nodose-septate hyphae from which they arise. Behind the margin the fibre hyphae have thicker walls and bend upwards towards the upper surface. Few nodose-septate hyphae are present in the upper context, which

consists mainly of parallel or intertwined, unbranched, fibre hyphae with yellow-brown, thickened walls and narrow or occluded lumina, and, numbers of hyaline or sub-hyaline, thick-walled or solid, fibre hyphae with short, tortuous, branches interwoven with long, unbranched, fibre hyphae. At the upper surface the ends of the fibre hyphae are packed at a common level and are bent over to lie flat on the surface. These elements are covered by a thin, transparent, lacquer-like substance to form the characteristic glabrous surface of the carpophores. In carpophores with dark, reddish-brown stains over their upper surfaces, thin-walled, nodose-septate hyphae with deeply staining contents are present in large numbers among the fibre hyphae below these areas. From these hyphae, dark-brown, swollen, cuticular cells and hyphae with irregular projections, extend into the dark, stained area. Here, these elements are agglutinated by means of a dark-brown, lacquer-like substance into a hard, brittle crust, up to 120μ thick, over the ends of the fibre hyphae (Fig. 43 c).

In the lower context, long, unbranched, yellow-brown, fibre hyphae are arranged more or less parallel to the direction of growth but some turn downwards into the trama of the dissepiments. Other unbranched, yellow-brown, fibre hyphae with prominent lumina, mostly unbranched, but very tortuous, are tightly interwoven with these straight fibre hyphae and with numerous, hyaline, short, much-branched, thick-walled or solid, fibre hyphae and branching, thin-walled, nodose-septate hyphae, to form the dense, tough tissues of the trama. In this tissue, thin-walled, nodose-septate hyphae ramify among the thick-walled hyphal elements, branching frequently towards the surfaces of the pores where they bear the basidia on numerous, short branches.

Decay and hosts

This species causes a diffused white rot of dead branches of hardwood trees.

Specimens examined

Herb. PRE: 11521, on decayed wood, Kentani, C.P., May 1918; 11545, on living branch, Buccleugh, Natal, July 1918; 15541, on *Albizzia gummifera,* Stellenbosch, C.P., Sept. 1916; 17099, Wilderness, C.P., May 1923; 25477, Mount-aux-Sources, Natal, July 1928; 23689, Margate, South Coast, Natal, Feb. 1931; 28259, on dead wood, Pretoria, Transvaal, March 1935; 28889, on dead branches, Drakensberg, Natal, July 1937; 31549, on dead branches, Ivy Range, Moodies, Natal, Aug. 1915; 31669, Ginginhluvu, Natal, May 1916; 31674, Ginginhluvu, Natal, July 1915; 31702, dead stump, Stellabush, Durban, Natal, Oct. 1916; 31850, New Germany, Natal, April 1917; 31865, on dead wood, Bluff, Durban, Natal, May 1917; 31894, on dead wood, Mazoe, Rhodesia, May 1917; 31900, Stellabush, Durban, Natal, July 1917; 31920, Bluff, Durban, Natal, Aug. 1917; 33066, on dead wood, Xumeni Forest, Donnybrook, Natal, Dec. 1940; 33207, on dead wood, Rustenburg, Transvaal, May 1939; 35329, on *Quercus* sp., Pietermaritzburg, Natal, 1943; 36422, on dead wood, Chiradzulu, Malawi, Sept. 1944; 36848; 36866, on dead wood, Vumba Mts., Umtali, Rhodesia, July 1948; 39112, on dry branch, Isipingo, Natal, Oct. 1950; 42067, Senanga, Barotseland, Aug. 1952; *42159, on dead hardwood branch, Bushbuckridge, Tvl., Feb. 1961; *42161, on dead hardwood branch, Bushbuckridge, Tvl., Feb. 1961; 43116, on *Acacia karroo* stump, Tongoland, Natal, March 1965.

Herb. STE: 222, old rotting wood, Durban; 223, Rhodesia; 224, old log, Durban; 1044, on wild *Ficus* sp., Kyrassa, E. Africa, July 1922; 1485, op droë hout, Houtbos, Transvaal, Julie 1924; 2414, in thick forset, Umtali, Rhodesia, No. 1926.

Discussion

Although the cultural characters of *Hexagona tenius* have not been described before, it is evident that, with its cultures which produce extra-cellular oxidase enzymes, and form fibre hyphae, cuticular cells and clamp connections on its thin-walled hyphae, this species fits well into Group 51. Indeed, it resembles a number of other species also present in this group (Nobles, 1958 b, 1965) so that confusion

may arise when it is attempted to identify isolates from unknown decays; but when the absence of secondary spores in cultures, the presence of fibre hyphae and the possession of white, woolly to felty mat which becomes largely covered by a reddish-brown crust, are considered together with the geographical origin of the specimen, cultures of *Hexagona tenuis* may be recognized with a fair degree of certainty.

The carpophores of *Hexagona tenuis* were seen to consist of thin-walled, nodose-septate hyphae, aseptate, branched and unbranched fibre hyphae or binding hyphae. The cuticular cells present in some carpophores are modified terminal portions of thin-walled, nodose-septate hyphae in which the septa and clamp connections are often involved. Since hyphae with clamp connections are regarded as generative hyphae by Corner (1953) and Cunningham (1946, 1954) only three types of hyphae are present in carpophores of *Hexagona tenius* which thus have trimitic hyphal systems, sensu Corner (1953).

The cuticular cells, which are the structural elements of the dark, reddish-brown, crustose areas of some carpophores, were not always present in all carpophores. They were often absent from some carpophores of a collection in which crustose areas were present on others, an inconsistency also reported by Van der Bijl (1922 a). No satisfactory reason for this sporadic appearance can be given although it is possible that this may be influenced by the conditions under which the carpophores develop. Because of this sporadic presence, however, the value of cuticular cells as a useful diagnostic character in carpophores is reduced considerably.

From the above description it is evident that the structures formed in cultures of *Hexagona tenuis* are usually also present in the carpophores from which they were made. It is noteworthy that the branched fibre hyphae of the cultures did not resemble those of the carpophores but similar differences were also observed in other species. Also, the cuticular cells formed in cultures were larger, had thinner walls and appeared more regularly and extensively than in the carpophores, but were undoubtedly homologous structures. Their more extensive development in cultures can be asscribed only to the existence of more favourable conditions for their development.

The anatomical characters of *Hexagona tenuis* have not been described before and little is known about them in apparently closely related species. Lloyd (1910) mentioned context colour but no hyphal characters in his Synopsis of the genus *Hexagona* Fr. Van der Bijl (1922 a) stated that hyphae of *Hexagona tenuis* were 4μ in diameter. Overholts (1953) described hyphae of *Hexagona variegata*, a species which he considered to be closely related to *Hexagona tenuis*, as "pale brown in KOH, long and flexuous, simple or nearly so, mostly with partly thickened walls, with no cross-walls or clamps, 4 — 6μ in diameter." Pinto-Lopes (1952) reported that secondary hyphae of *Hexagona nitida* Mont., are hyaline, nodose-septate and the tertiary hyphae are brownish, thick-walled or solid and septate. Fidalgo & Fidalgo (1962) reported that carpophores of *Hexagona apiaria* Pers. ex Fr. and *Hexagona hirta* (Beauv. ex Fr.) Fr., have trimitic hyphal systems. The above descriptions of the hyphal characters of *Hexagona tenuis* thus generally agree with observations by other workers on related species.

The description also agrees with Fidalgo & Fidalgo's (1962) report of the hyphal characters and hyphal systems of *Hexagona apiaria* Pers. ex Fr., the type species of the genus according to some authors (Cooke, 1959); but considerable uncertainty exists about the identity of the type species of the genus *Hexagona* Fr. This problem was discussed by Donk (1960) who concluded that *Favolus hirtus* P. Beauv. should be regarded as the type species. Until this problem is solved

however, the affinities of *Hexagona tenuis* with the genus *Hexagona* Pollini per Fr. cannot be determined with any degree of certainty.

Imazeki (1943), however, transferred *Hexagona tenuis* to the genus *Daedaleopsis* Schroet. with the remark that "it has no affinity to *Hexagona apiaria* the type of the genus *Hexagona* sensu stricto. This species is unique but it is safe for the writer that it would be placed under *Daedaleopsis* at least, if we do not erect a new genus for the species. The species connects with the genus *Daedaleopsis* through *D. conchifer* or *D. corrugata*." This is contradicted by the descriptions given here and the report by Fidalgo & Fidalgo (1962) who described the trimitic hyphal system in carpophores of *Hexagona apiaria*. In comparison with *Daedalea confragosa* L. ex Fr., the type species of *Daedaleopsis* Schroet., *Hexagona tenuis* differs from it mainly by the presence of binding hyphae throughout the context tissues of its thin carpophores, its large, cylindrical basidiospores and the large regular, shallow pores of its carpophores. These differences are of a similar nature to those between *Trametes suaveolens* and *Lenzites betulina* and because these are considered to be distinct genera, it appears best, at this stage, to regard *Daedalea confragosa* and *Hexagona* tenuis as species of separate genera although the two species are similar in many respects.

Comparison of *Hexagona tenuis,* with *Trametes corrugata,* presumably Imazeki's (1943) "*D. corrugata,*" which is also included and described above in this group, shows the latter to have construction of the carpophores and binding hyphae which are unlike those of the fruit-bodies of *Daedalea confragosa* and *Hexagona tenuis*. It thus seems to be extremely unlikely that *Hexagona tenuis* can be related to *Daedalea confragosa* through *Trametes corrugata*.

More information, however, is required on the hyphal and anatomical characters of more species of the genera *Daedaleopsis* Schroet. as well as *Hexagona* Fr. before a satisfactory conclusion can be reached about the nature of their relationships. The solution of the problem of the type species of the genus *Hexagona* Fr. will be an important step in the determination of this relationship.

Note added in proof.

In later works K. Fidalgo advanced reasons for accepting the designation by Clements and Shear of *Hexagona crinigera* Fr. as lectotype of the genus *Hexagona* (Taxon 1968: 37-43) and excluded *Hexagona tenuis* Hooker ex Fries from this genus (Mem. N.Y. Bot. Gard. 1968: 100).

Trametes acupunctata *Berkeley,* Jour. Lin. Soc. 13, 164, 1873;

Coltricia acupunctata (Berk.) G. H. Cunningham, Proc. Linn. Soc. N.S.W. 75, 216, 1950.

Cultural characters

Growth is moderately rapid, the colonies reaching radii of about 115 mm in one week and covering the plates in 3 — 4 weeks. The advancing zone is even or slightly bayed, mat appressed for short distance, then raised, becoming thin, cottony and gradually passing into a thin, felty zone, or, bordering abruptly on a clear zone of submerged mycelium around the inoculum. After 2 — 3 weeks the mat becomes zonate with increasingly woolly texture towards the inoculum, with crustose areas of "verona brown," "natal brown" or "bister" developing over the clear areas and along the side of the plate. With increasing age the mycelial mat thickens and the dark-coloured, crustose areas increase in size until at six weeks the mat consists of thin, downy, white mycelium over the youngest parts,

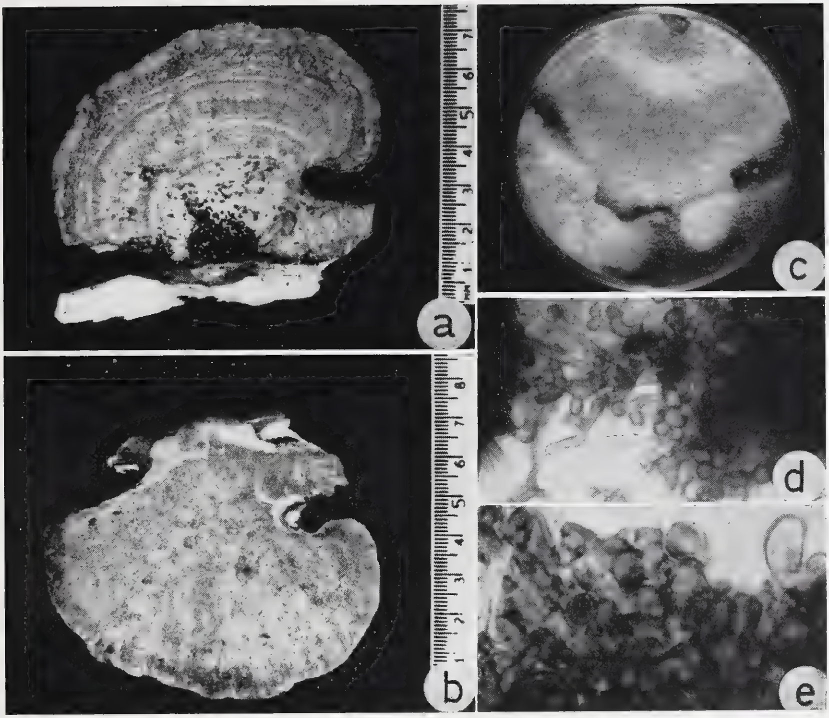

FIG. 45. — **Trametes acupunctata.** (a) Upper surface and (b) lower surface of carpophore of PRE 42440; (c) culture of PRE 42440 at six weeks; (d) cuticular cells from culture, × 100; (e) hyphae with partly thickened walls and irregular projections from dark-brown, crustose areas on upper surface of carpophore, squash mount in KOH, × 500.

often bordering abruptly on clear areas of submerged mycelium over which crustose areas of "Prout's brown," "cinnamon brown," "Verona brown" or "Natal brown" are forming, or, passing over successive zones of increasingly woolly to felty mycelium mostly fairly smooth or becoming pebbly towards the inoculum, white or "pale ochraceous buff" or "pinkish buff" in the older parts and bordering abruptly on the irregular, sunken "hazel," "ochraceous tawny," "cinnamon brown," "sayal brown," "Natal brown" or "Prout's brown," crustose areas which may cover up to half the area of the mat. The reverse bleaches at first, then darkens to deep, brown colours in which sharp, darker lines indicate the limits of the crustose areas. No odour or faint, mushroomy odour is given off. Cultures give a weak positive reaction when tested for extra-cellular oxidase enzymes with gum guaiacum solution (Nobles, 1958 a). On gallic acid and tannic acid media no diffusion zones are formed and no growth or a trace of growth occurs.

Advancing mycelium: hyphae hyaline, simple or branching, nodose-septate, thin-walled and staining deeply in phloxine 2.5 — 4.5μ in diameter (Fig. 46 a).

Aerial mycelium: (a) hyphae as in the advancing zone; (b) fibre hyphae hyaline with thick, refractive walls and prominent, aseptate lumina, widening towards the thin-walled ends, unbranched, or branching occasionally, 3.0 — 5.0μ in diameter (Fig. 46 b); (c) narrow hyphae repeatedly branched, the branches tapering, walls hyaline partly thickened, the lumina prominent and aseptate, 0.5 — 1.2μ in diameter (Fig. 46 c); (d) nodose-septate hyphae with numerous short, stout branches or projections, thick, brown walls and narrow or partly occluded lumina, or, blown out into thin-walled processes or cuticular cells, 3.0 — 20μ in diameter (Fig. 45d, 46d).

Scbmerged mycelium: hyphae as in the advancing zone.

Carpophore characters

Carpophore annual, lignicolous, sessile, dimidiate, occasionally imbricate, often slightly concave, coriaceous, firm, rigid, almost woody, 3.5 — 20 x 2.0 — 9.0 x 0.2 — 2.0 cm; surface glabrous with fine radiating grooves and ridges traversed by concentric grooves, ridges, and tubercles, fawn to olive brown, often with patches of soft, dark cream-coloured or pale buff mycelium over the surface, or, dark reddish-brown crustose areas over the older parts; margin undulate and sinuose, concolourous with upper surface; pore surface dark olive-brown, poroid; pores rounded to somewhat daedaloid, 2 — 4 mm; dissepiments even, thin, tubes short, .02 — 0.5 mm deep becoming olivaceous brown inside; context olive-brown, fibrous, zonate, darkening in KOH, 0.1 — 12.0 mm thick.

Hyphal characters. Carpophores consist of: (i) hyaline, branching, nodose-septate, thin-walled hyphae with deeply staining contents, 2.0 — 3.0μ in diameter (Fig. 46 e); (ii) fibre hyphae long, unbranched, straight or somewhat tortuous, yellowish-brown, walls thickened, lumina narrow widening towards the thinner-walled ends, aseptate, often with staining contents, 2.0 — 5.0μ in diameter and arising from thin-walled, nodose-septate hyphae (Fig. 46 f); (iii) dark, yellow-brown, thick-walled hyphae, 3.0 — 4.0μ in diameter with short, thick, lateral projections or inflated portions up to 10μ in diameter (Fig 45 e).

Hymenium: basidia hyaline, long clavate, 16.0 — 22.0 x 6.0μ bearing four straight sterigmata, 3.0μ long (Fig. 46 g); basidiospores hyaline, long ellipsoidal to cylindrical, smooth, thin-walled, 5.0 — 8.0 x 2.5 — 3.5μ (Fig. 46 h).

Construction. At the margin, the carpophore consists of long, unbranched fibre hyphae, more or less straight, with the walls thickened and lumina prominent, aseptate, more or less parallel to one another and loosely intertwined. Intertwined with them are the narrow, branching, thin-walled, nodose-septate hyphae with deeply staining contents, from which they arise. In the upper context, behind the margin, fibre hyphae with much thickened walls and narrow, aseptate lumina, which constitute the bulk of the tissues, lie more or less parallel to one another and slightly intertwined, bending upward towards the upper surface where their ends are closely packed at a common level and become agglutinated by a thin layer of transparent lacquer-like material into a glabrous, cuticular surface. Narrow, branching, thin-walled, nodose-septate hyphae are intertwined with the fibre hyphae in the upper context and below the surface cuticle. On some specimens dark-brown, irregular, crustose areas may be present on the older parts of the upper surface. These consist of dark, yellow-brown hyphae with walls partly thickened or solid and with short, irregular, lateral projections and small, irregular swellings all agglutinated by brown, resin-like material into a hard, brittle mass forming a layer up to 50μ thick in which individual elements are distinguished with difficulty (Fig. 45 e). The lower context is similar to the upper but in the trama of the

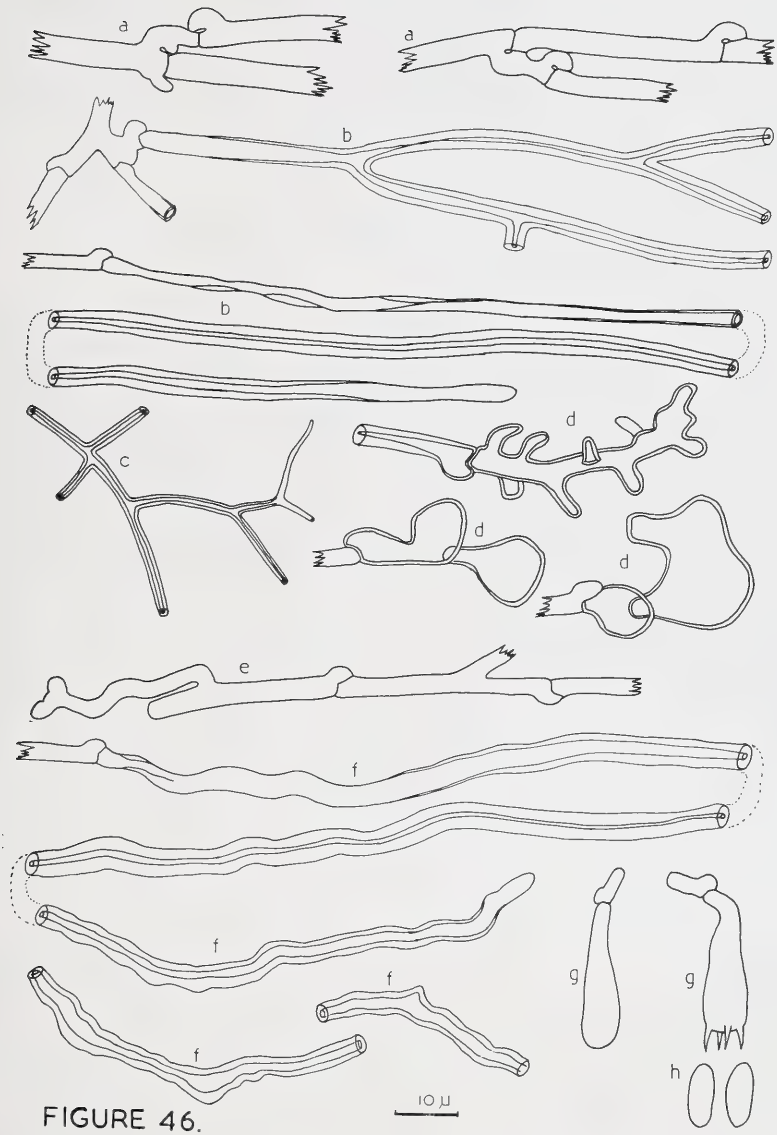

FIG. 46.— **Trametes acupunctata.** a - d. Structures from cultures: (a) thin-walled, nodose-septate hyphae from advancing zone; (b) fibre hyphae; (c) narrow, repeatedly branched hyphae; (d) nodose-septate hyphae with irregular projections and cuticular cells.
e - h. Structures from carpophores: (e) thin-walled, nodose-septate hyphae; (f) fibre hyphae; (g) basidia; (h) basidiospores.

tubes the fibre hyphae are narrower, more flexuous and with thinner walls and wider lumina than in the context. These hyphae become tightly interwoven to form a dense homogeneous tissue distinct from the context tissues. In the trama the thin-walled, nodose-septate hyphae become very numerous, narrow and branch frequently, the branches interwoven with and ramifying among the fibre hyphae, finally emerging at the hymenial surfaces where the clavate basidia are borne on short, terminal branches of these nodose-septate hyphae.

Decay and hosts

This fungus is fairly common on dead hardwood logs on which it causes a pale brown rot slightly lighter in colour than the wood.

Specimens examined

Herb. PRE: 11283, on *Acacia mollissima* stump, Cramond, Natal, April 1911; 13938, on *Acacia mollissima*, stump, Cramond, Natal, April 1911; 15546, on *Acacia mollissima* stump, New Germany, Natal, April 1917; 15591, on dead *Vepris lanceolatis*, Buxton, C.P., Aug. 1916; 27554, on dead wood, Table Mountain, Natal, Oct. 1929; 30821, on indigenous wood, Port St. Johns, C.P., Aug. 1937; 31555, on dead wood, Branders Main Forest, Natal, Aug. 1915; 31573, on dead wood, Branders Main Forest, Natal, Aug. 1915; 31587, on dead wood, Branders Main Forest, Natal, Aug. 1915; 31663, on dead wood, Ngoye, Natal, May 1916; 31733, on dead wood, Ngoye, Natal, May 1916; 31754, on dead wood, Durban, Natal, March 1917; 33208, on dead wood, Rustenburg, Tvl., May 1939; 34368, on dead wood, Hluhluwe, Natal, Oct. 1935; 42034, on dead wood, Knysna, C.P., 1959; *42171, decayed hardwood log, F. C. Erasmus Nature Res., Tvl., Feb. 1961; 42253, on dead log, Sabie, Tvl., Apr. 1962; *42440, decayed hardwood log, near Bushbuckridge, Tvl., Feb. 1961.
Herb. STE: 158, on dead logs, Bluff, Durban; 200, on dead logs, Krantzkloof, Natal, Jan. 1921; 350, on dead logs, Krantzkloof, Natal, Jan. 1921.

Discussion

The presence of nodose-septate, thin-walled hyphae, fibre hyphae and cuticular cells in its cultures, partly qualify *Trametes acupunctata* for inclusion in Group 51; but the weakly positive reaction of its cultures when tested for extra-cellular oxidase is in striking contrast to the strong positive reactions of other species in this group. The negative oxidase reaction of this species on gallic acid and tannic acid media together with the fact that this species causes a brown rot suggests that its inclusion in the large number of species of which the cultures do not produce extra-cellular oxidase may be justified. In that case it would then constitute a new group beyond Group 25, in which cuticular cells, fibre hyphae and nodose-septate hyphae are formed in cultures which lack extra-cellular oxidase. A group with this combination of characters is not provided in Nobles' keys, (Nobles, 1958 b, 1965); but because of the weak positive reaction for extra-cellular oxidase when its cultures are tested with gum guaiac solution, *Trametes acupunctata* must be included in Group 51 with which it also agrees in hyphal characters.

In carpophores of *Trametes acupunctata,* only two types of hyphae are present, viz.: thin-walled, hyaline nodose-septate hyphae and yellow-brown, thick-walled, unbranched fibre hyphae. No branched fibre hyphae or binding hyphae were found in any carpophore and the somewhat rigid, woody and fibrous texture of the fruit-bodies is due to the presence of these tightly packed and intertwined fibre hyphae. This species thus have carpophores with dimitic hyphal systems sensu Corner, (1932 b, 1953) and Cunningham (1946, 1954). In this respect fruit-bodies of *Trametes acupunctata* differ in hyphal characters and construction from those of all other species of which these characters are known, in this group.

Also present in some of the carpophores are dark-brown, thick-walled hyphae with the terminal parts inflated or distended into irregular projections which constitute the dark-brown crustose areas. These structures appear to be the counterparts in the fruit-bodies of the cuticular cells in the cultures. They occur in the same relative position as similar structures in other species in this group and apparently arise from thin-walled, nodose-septate hyphae in the upper surface of the carpophores. They are agglutinated into a very hard and very brittle structure which could not be prepared satisfactorily for proper examination. In view of their character and position in the fruit-bodies however, it seems extremely likely that they are the ends of thin-walled, nodose-septate hyphae modified into cuticular cells an dhyphae with irregular projections.

From the descriptions it is clear that most of the structures formed in cultures are also present in the fruit-bodies from which they are made. Only the narrow, hyaline, branched hyphae which are present in the cultures, over the agar, could not be located in the carpophores. Similar hyphae had been noticed in cultures of other species too e.g. *Polyporus versicolor,* but were absent from their carpophores. The absence of these hyphae from the carpophores could be due to their formation inside the wood on which the carpophores are formed, or to the existence of conditions in cultures which allow their formation and the absence of these conditions in growing carpophores. It was not possible to investigate either alternative.

Cuticular cells formed in cultures with greater regularity than in the relevant carpophores. The structures were more readily recognizable and could be traced to their origins with ease in the cultures. It appears that conditions which favour their formation occur more frequently in cultures than in carpophores. Their presence in cultures may thus be useful as a diagnostic feature when cultures from unknown decays have to be identified but their sporadic appearence on carpophores in nature diminishes their value as a character of taxonomic importance.

The hyphal characters and construction of the carpophores of *Trametes acupunctata* differ strikingly from those of other species in this group of which these characters are known. Much branched fibre hyphae or binding hyphae (Corner, 1932 a) are absent from carpophores of *Trametes acupunctata* but are present in those of *Daedalea confragosa, Hexagona tenuis, Trametes corrugata,* and *Fomes fomentarius* (Teixeira, 1962 b). As the absence or presence of types of hyphae in carpophores is considered to be of importance at the generic level by a number of workers (Teixeira, 1962 b; Bondartzeva, 1961), *Trametes acupunctata* cannot be considered to be congeneric with any of these species.

Although originally placed in the genus *Trametes* Fr. by Berkeley (loc. cit.) it is clear that *Trametes acupunctata* has little in common with *Trametes suaveolens,* (L. ex Fr.) Fr. the type of this genus. It differs from *Trametes suaveolens* by having a brown context of simple construction, by the presence of cuticular cells in its cultures and carpophores, by causing a brown rot, and in the weak production or absence of extra-cellular oxidase enzymes in its cultures.

Cunningham (1950 b) transferred *Trametes acupunctata* to the genus *Coltricia* S. F. Gray which he characterized as having pileate fruit-bodies with a "monomitic hyphal system, hyphae long, ribbon-like, branched and septate, without clamp connections." Since this description does not fit the hyphal characters and construction of the fruit-bodies of *Trametes acupunctata* as described above, this species cannot be assigned to the genus *Coltricia.*

Trametes acupunctata thus differs in respect of cultural characters, carpophore characters and type of decay from the type species of genera to which it had

been assigned. It is not well placed in Group 51 either, because of the inconsistent oxidase reactions of its cultures while its carpophores differ in construction from those of other species in this group of which these characters are known. The combination of characters found in its cultures and carpophores are not known to exist in any other species at present, largely because of the limited knowledge of hyphal characters and fruit-body construction of poroid Hymenomycetes. Its taxonomic position is thus uncertain but a more suitable position cannot be suggested. Description of a new genus based on this species may thus be justified but because future studies may reveal a genus to which *Trametes acupunctata* may be satisfactorily assigned it is proposed not to transfer it to a new genus which may well become an addition to an already long list of generic synonyms.

Resumé

From these descriptions it is evident that the four species of Group 51 included in this study possess the cultural characters which justify their inclusion in this group. With the exception of *Trametes acupunctata,* they share a number of correlated characters, viz.: the production of extra-cellular oxidase, association with white rots, the presence of nodose-septate hyphae, fibre hyphae and cuticular cells. It appears that these species share a common ancestry but show diversity in the elements of their carpophores. Its association with a brown rot, uncertain extra-cellular oxidase production in culture and absence of binding hyphae from its carpophores, suggest that the characters which *Trametes acupunctata* has in common with the other three species, may have developed as a result of convergent evolution.

5.9 Group 53

Cultures of species in this group have white mycelial mats covered by extensive, wrinkled, brown, pseudo-parenchymatous areas. Extra-cellular oxidase enzymes are produced. The thin-walled hyphae have simple clamps at the septa and may remain thin-walled or give rise to thick-walled, brown hyphae with interlocking projections. Thick-walled, aseptate fibre hyphae are also formed. Their basidiospores are large, cylindrical or ellipsoid-cylindrical and the interfertility for species of which this character is known, is the tetrapolar type. Carpophores of these species are alike in being stipitate.

Polyporus sacer *Afz. ex Fries,* Epicr., 436, 1836.

Cultural characters

Growth is moderately rapid the colony reaching a diameter of 15 mm after 1 week and covering the plate in 3 to 4 weeks. Advancing zone even, hyphae raised almost to the limit of growth Mat at newest growth white, cottony to woolly, thin, towards the inoculum at first appressed and becoming woolly-felty with faint, radiating grooves or woolly-felty streaks, then suddenly pale "cream color" with slightly uneven, lacunose surface and fine droplets of colourless liquid on it, around the inoculum. At three weeks the margin straightens as growth proceeds more rapidly adjacent to the sides of the dish. Mat becomes more appressed to sub-felty with pellicular areas developing at concentric grooves of previous week's growth and coalescing into pellicular areas which soon become

covered by raised, crustose areas. Mat remains white but crustose areas are at first "cinnamon buff" and bordering abruptly on the white mat, later darkening to "cinnamon." Or, zones of clear, submerged mycelium develop after 2-3 weeks over which crustose areas of "ochraceous tawny," raised mycelium, smooth at first but later wrinkled, and becoming "clay colour," soon form. At six weeks the mat is usually white or pale "cream color," downy or pellicular in the younger parts with smooth or somewhat wrinkled crustose areas in a wide zone around the inoculum and with scattered, raised, crustose patches over the older parts of the mat. Colours on these range from "ochraceous tawny" to "clay colour" or "light pinkish cinnamon" to "cinnamon." The reverse is bleached after 3 weeks but dark brownish colours gradually develop in the agar. A pleasant, fragrant odour is given off till about the fourth week but then gradually diminishes. A weak positive reaction is obtained when the culture is tested for extra-cellular oxidase enzymes. No growth takes place on gallic acid and tannic acid media but small diffusion zones are formed on both media within one week.

Advancing mycelium: hyphae hyaline, thin-walled branched or unbranched with simple clamp connections at the septa, 2.0 — 4.5μ in diameter (Fig. 48 a).

Aerial mycelium: (a) hyphae as in the advancing zone; (b) fibre hyphae unbranched or branching, long, more or less straight, hyaline, the walls thickened, lumina narrow or occluded for most of their length, widening at the extremities, aseptate, 1.0 — 3.0μ in diameter (Fig. 48 b); (c) narrow fibre hyphae, hyaline with numerous short tapering branches and mostly solid, 0.5 — 1.0μ in diameter (Fig. 48 c); (d) nodose-septate hyphae with interlocking projections and short, thick, lateral branches, sub-hyaline to pale yellowish brown, the walls thickened and lumina narrow or occluded, 3.0 — 8.0μ in diameter with projections up to 10u long (Fig. 48 d).

Submerged mycelium: hyphae as in the advancing zone but more tortuous and wider, 2.5 — 6.0μ in diameter.

Carpophore characters

Carpophore annual, terrestrial, solitary rarely grouped; pileus orbicular, tough coriaceous to woody, velutinate to glabrous, rugulose, slightly furrowed, concentrically sulcate or zoned, "tawny olive," "snuff brown" to "Verona brown," "Prout's brown" or "bister" and "dark olive" in concentric zones, centrally stipitate, 6.0 — 10.0 cm in diameter, 0.15 — 0.3 cm thick; margin acute, thin, entire, white or concolorous; pore surface white drying to "pale ochraceous buff", "warm buff" or "clay color," poroid; pores daedaloid, rounded or angular, 2/mm; dissepiments thin, even in younger parts but in older parts, radially raised; tubes concolorous up to 2.5 mm deep; context tough, fibrous, white to pale "cream color," 0.75 — 1.5 mm thick; stipe erect, tapering apically mostly slender, smooth, velutinate, "tilleul buff" to "wood brown" 0.3 — 1.4 x 4.5 — 15 cm, subtubular to tubular, context white, arising from basal sclerotium; sclerotium ovoid to irregular, rugose to rimose, horny, hard, concolorous with stipe, 1.5 — 5.0 x 2.5 — 7.5 cm; context white or "pale tilleul buff," firm, woody.

Hyphal characters. Carpophores consist of: (i) hyaline, thin-walled, nodose-septate hyphae, branching at the septa, 1.8 — 3.5μ in diameter (Fig. 48 e); (ii) fibre hyphae long unbranched or with an occasional long branch, more or less straight or tortuous, widest near middle, the walls hyaline, thick, refractive, lumina narrow or occluded, aseptate, 1.5 — 6.0μ in diameter (Fig. 48 f); (iii) fibre hyphae with many lateral branches, walls hyaline, thickened, lumina narrow or occluded, aseptate, 1.5 — 3.5μ in diameter (Fig. 48 g); (iv) nodose-septate hyphae with

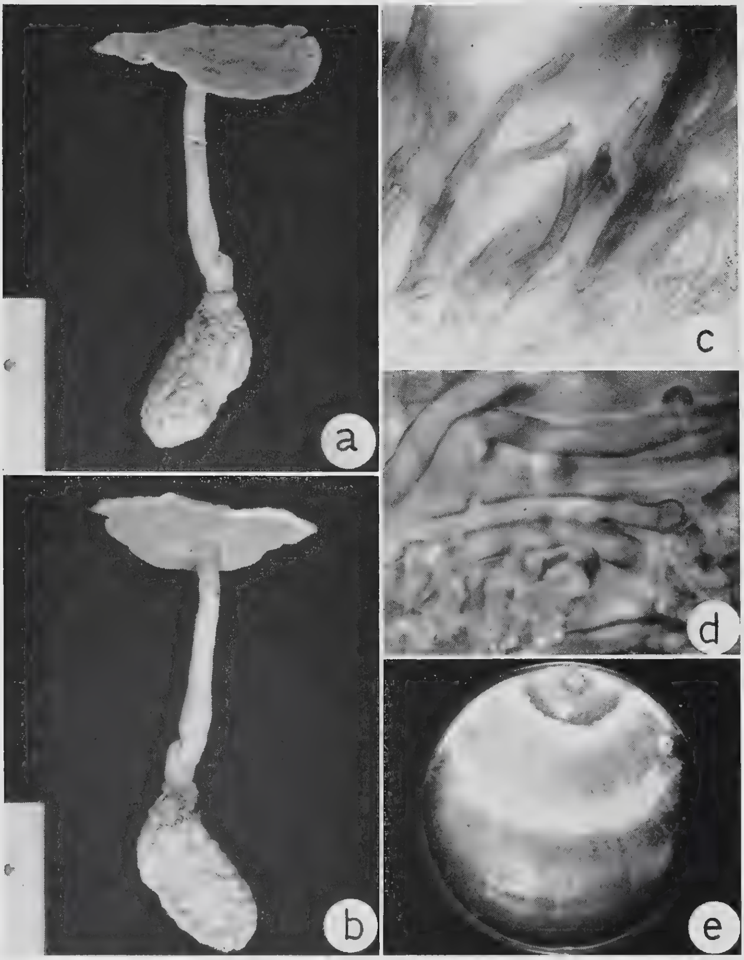

FIG. 47.—**Polyporus sacer.** (a) Carpophore of PRE 31545 showing upper suface and (b) hymenial surface; (c) dark-coloured, thick-walled, nodose-septate hyphae forming hairs on upper surface of carpophore, × 500; (d) cuticular cells and "hairs" from upper surface, × 1000; (e) culture of PRE 42163 at six weeks.

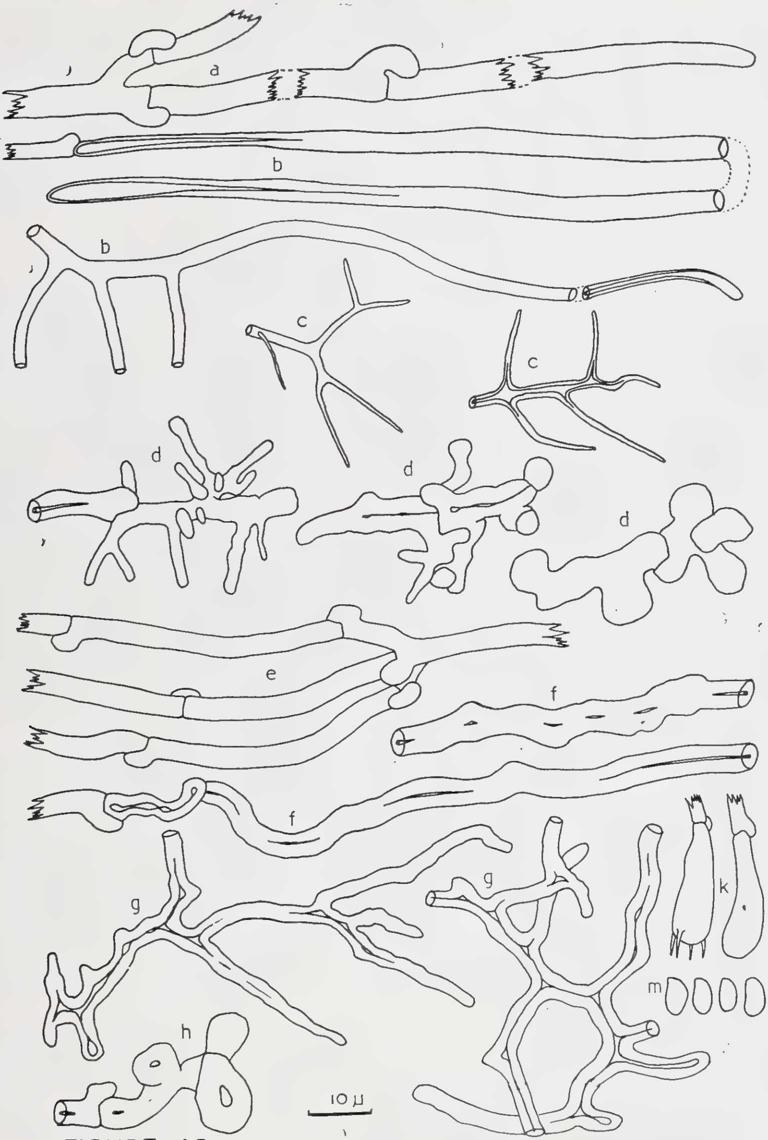

FIGURE 48.

Fig. 48.—**Polyporus sacer.** a - d. Structures from cultures: (a) thin-walled, nodose-septate hyphae from advancing zone; (b) fibre hyphae; (c) narrow hyphae with numerous short, tapering branches; (d) nodose-septate hyphae with interlocking projections.

e - m. Structures from carpophores: (e) thin-walled, nodose-septate hyphae; (f) unbranched fibre hyphae; (g) fibre hyphae with numerous short, lateral branches; (k) basidia; (m) basidiospores.

thick brown walls and narrow or partly occluded lumina and solid or sub-solid clamp connections, 4.5 — 10.0μ in diameter (Fig. 47 c); (v) nodose-septate hyphae with thick hyaline walls distended into interlocking projections, 4.0 — 8.5μ in diameter (Fig. 47 c, 48 h).

Hymenium: basidia hyaline long clavate 14.0 — 18.0 x 5.0 — 17.0μ bearing four sterigmata 2.0 — 3.0μ long (Fig. 48 k); basidiospores hyaline, ovoid to ellipsoid, flattened on one side, smooth, thin-walled, 5.0 — 7.0 x 3.0 — 4.5μ (Fig. 48 m); hyphal pegs numerous, white, long-conical up to 200μ long.

Construction: At the margin the pileus consists of fibre hyphae, hyaline and straight or flexuous, unbranched and with narrow or occluded lumina up to 6.0μ in diameter, intertwined with one another and interwoven with numerous hyaline, branching, thin-walled, nodose-septate hyphae 1.8 — 3.5μ in diameter, from which they arise. At the upper part of the margin, numerous nodose-septate hyphae are present, their walls distended into irregular, inter-locking projections which thicken and turn brownish simultaneously. A very short distance from the margin these hyphae are agglutinated into a hard, brittle, brown cuticle 30 — 50μ thick over the upper surface. The uppermost layers of this cuticle consists of nodose-septate hyphae with thick, brown walls lying parallel to the direction of growth of the pileus and agglutinated by a brownish, lacquer-like substance onto the surface to form glabrous zones (Fig. 47 c). Or, free, nodose-septate hyphae with thick, brown walls project upward from the cuticle to form the velutinate zones (Fig. 47 c). Below the cuticle and behind the margin the context consists mainly of intertwining hyaline, unbranched, straight or flexuous, fibre hyphae, solid or sub-solid with a thin layer of numerous, thin-walled, nodose-septate hyphae below the cuticle, freely intertwined with the ends of the fibre hyphae, some of which are agglutinated into the cuticle. Interwoven with the long fibre hyphae are fibre hyphae with short, sub-solid or solid, lateral branches which bind them together into the tough tissues of the pileus.

In the lower context and trama of the tubes the tissues are more dense and consist of long, fibre hyphae, more tortuous, generally narrower and more frequently branched than in the upper context, the branches long and tapering, and tightly interwoven with fibre hyphae with many short branches binding them together into a dense, even, tough tissue. Also interwoven with these hyphae are thin-walled, nodose-septate hyphae with deeply staining contents, branching repeatedly and becoming increasingly numerous towards the hymenial surfaces where they bear the basidia on numerous short branches. From the tissues of the dissepiments, hyphal pegs, each consisting of a bundle of parallel ends of fibre hyphae, project into the pore space for up to 200μ.

The tubular stipe consists mainly of long, unbranched, sub-solid to solid, hyaline fibre hyphae 3.0 — 6.0μ in diameter at the widest middle part, intertwined and parallel to the length of the stipe. Interwoven with them are narrower, hyaline fibre hyphae with numerous short tortuous branches with thick walls and prominent lumina, 1.0 — 1.5μ in diameter. Thin-walled, nodose-septate hyphae are interwoven with the fibre hyphae and become more numerous towards the outer and inner surfaces where they give rise to plectenchymatous layers of thick-walled cells 40 — 90μ in thickness on the inner and outer surfaces.

The sclerotium consists mainly of interwoven branched and unbranched hyaline fibre hyphae apparently without directional orientation and thin-walled nodose-septate hyphae in a homogeneous context and covered by a hard rind 90 — 180μ thick, apparently consisting of thick-walled, nodose-septate hyphae.

Decay and hosts

This fungus does not cause decay of timber but grows in humus rich soil in damp sub-tropical areas.

Specimens examined

Herb. PRE: 9112, Elandshoek, Tvl., Aug. 1915; 11519, Kentani Distr., C.P., May 1918; 31545; 36590, in soil in forest, Njala, Sierra Leone, Feb. 1947; *42163, on ground, F. C. Erasmus Nature Reserve, Tvl., Feb. 1961.

Discussion

The cultural characters of *Polyporus sacer* have not been described before but there can be no doubt that the presence of thin-walled, nodose-septate hyphae, fibre hyphae and hyphae with interlocking projections in cultures which produce extra-cellular oxidase enzymes, places this species in Group 53. This group includes 11 other species of stipitate polypores, all of which display very similar characters in culture (Nobles, 1958 b). In cultures of these species "the dark-brown, wrinkled, pseudoparenchymatous areas contrast sharply with the white cottony or woolly parts of the mats" (Nobles, 1958 b). Cultures of *Polyporus sacer* are lighter in colour over the crustose areas tending towards brownish yellow and the aerial mycelium is sub-felty rather than woolly. These characters serve to distinguish cultures of *Polyporus sacer* from those of other species in this group.

The carpophores of *Polyporus sacer* were shown to consist of five types of hyphae. Of these, the two types of hyphae with thickened walls have clamps at their septa and must be regarded as generative hyphae, sensu Corner (1932 a) and Cunningham (1946) and of the same type as the thin-walled nodose-septate hyphae. The unbranched and branched hyphae correspond to the skeletal and binding hyphae respectively so that the fruit-body of *Polyporus sacer* has a trimitic hyphal system sensu Corner (1932 b, 1953).

In this species it is again evident that the structures formed in its cultures are also present in the fruit-bodies from which they were made. There are no differences between the thin-walled, nodose-septate hyphae and fibre hyphae from the cultures and fruit-bodies except that fibre hyphae from cultures are somewhat less flexuous than those from the fruit-bodies; but the nodose-septate hyphae with thickened walls which form the "hairs" of the upper surface of the fruit-bodies, were not found in the cultures. In the fruit-bodies, these hyphae are closely associated with the nodose-septate hyphae with inter-locking projections. Both types arise from thin-walled, nodose-septate hyphae; but nodose-septate hyphae with interlocking projections did develop in the cultures. It thus appears that these hyphae may be variations of the same modification of nodose-septate hyphae but which develop under different conditions of growth. Conditions favourable for their development probably did not exist in the cultures.

The hyphal characters of *Polyporus sacer* have not been described before but Furtado (1965 a) stated that "the hyphal system and general habit of the species suggest that *Polyporus sacer* may belong to the genus *Amauroderma*, but basidiospores were not seen." Furtado (1965 a) further stated that "the arboriform skeletal hyphae (Teixeira 1956, 1962 a, b) are commonly found in the ganodermoid polypores and it seems probable that they are characteristic of the sub-family *Ganodermoideae*." He included the two genera *Ganoderma* Karsten and *Amauroderma* Murrill in this sub-family and distinguished between them on the basis of the shape of the thick-walled echinulate spores; but the specimens of *Polyporus sacer* examined for this study have thin-walled, short-cylindrical spores and arboriform hyphae were not found in their fruit-bodies. This species thus does not have the characters of the genus *Amauroderma* Murr. as described by Furtado (1965 a) and can therefore not be included in that genus.

Of the eleven species of stipitate polypores included by Nobles (1958 b) in her Group 53, the hyphal characters of only one species, *Polyporus squamosus* Fr., is known in detail from the description by Corner (1953). In this description, Corner stated that the young fruit-body of *Polyporus squamosus* has a monomitic hyphal system consisting of clamped, generative hyphae only. After a certain stage of maturity is reached, the generative hyphae develop 2 — 4 lateral, branching processes, which Corner designated as "binding hyphae." By growing laterally between the generative hyphae and developing thickened walls, these hyphae bind the generative hyphae into the tough, dry tissues of the mature fruit-body which has a dimitic hyphal system consisting of generative and binding hyphae. The hyphal characters and construction of the fruit-body of *Polyporus squamosus* are thus completely different from those of *Polyporus sacer* as described here.

The pileus of another stipitate species, *Polyporus arcularius*, was found to consist of nodose-septate hyphae with short inflated cells from which fibre-like, thick-walled processes arise and generally resemble those of the mature fruit-bodies of *Polyporus squamosus* as described by Corner (Dr. D. D. McLain, personal communication and demonstration).

Overholts (1953), in his brief descriptions of the hyphae of the fruit-bodies of the stipitate polypores included by Nobles (1958 b) in Group 53, mentioned the attenuated, whip-like ends of the branches of the hyphae in the pilei of *Polyporus arcularius*, *Polyporus brumalis*, *Polyporus squamosus* and *Polyporus tuberaster*. In the fruit-bodies of *Polyporus elegans*, *Polyporus melanopus* and *Polyporus varius* the hyphae are thick-walled and much branched, while those of *Polyporus fagicola* and *Polyporus radicatus* are thin-walled and tend to collapse. The hyphal characters of these stipitate species thus also differ among species of this group and all of them differ from the hyphal characters of *Polyporus sacer*. This species can therefore not be regarded as congeneric with any of the species included by Nobles (1958 b) in Group 53 of which two had been designated as generic types. No other species of stipitate polypore of which the hyphal characters, construction and general morphology of the fruit-bodies resemble those of *Polyporus sacer*, is known at present.

Donk (1960) showed that Fries indicated some affinity between *Polyporus sacer* and *Polyporus versicolor* by placing each of these species as the first species in two of his nine stirpes of his genus *Polystictus*. Donk (1962) stated later that Fries had conceived the taxon already before he decided to treat it as the separate genus *Polystictus*, and that Fries' remarks tend to show that "the genus *Polystictus* started with the conception of a stirpes typified by *Polyporus perennis* L. per Fr., in the first place, and a stirpes typified by *P. sacer* Afz. ex Fr." This close affinity with *Polyporus perennis* is not evident when the hyphal characters of these two species are compared. Cunningham (1948 e) described the hyphal characters of *Polyporus perennis* as "hyphal system monomitic, hyphae long, ribbon-like, branched and septate without clamp connections." This observation was confirmed by Overholts (1953). Because *Polyporus sacer* has a trimitic hyphal system in Corner's (1932 a, b) and Cunningham's (1946, 1954) terminology, the two species cannot be regarded as closely related at all.

The affinity between *Polyporus versicolor* and *Polyporus sacer* first indicated by Fries (in Donk, 1960) received additional support when Nobles (1965) included *Polyporus versicolor* together with three species of stipitate polypores as well as *Daedalea confragosa* and *Fomes scutellatus* in her Key Code 2.3.8.11 on the basis of their cultural characters. This group includes species of which the cultures produce extra-cellular oxidase and the thin-walled, nodose-septate hyphae are differentiated to form fibre hyphae and hyphae with interlocking projections.

Because cultures of *Polyporus sacer* agree with these characters, this species may also be included in Key Code 2.3.8.11 thus revealing similarities with cultures of *Polyporus versicolor*. The similarities in hyphal characters and construction of the pilei of *Polyporus sacer* and *Polyporus versicolor* are even more striking and suggest a much closer relationship between them than between *Polyporus sacer* and the other species of stipitate polypores discussed above. An important difference between them, however, exists in the nature of the construction of the upper surface of their pilei. While the upper surface of both species may be described by the term "trichoderm" (Lohwag, 1940; Furtado, 1965 a) the "hairs" of the trichoderm of *Polyporus versicolor* consist of the ends of fibre hyphae (skeletal hyphae) which project from a dense layer of agglutinated hyphae (Fig. 47 c), whilst the "hairs" of the trichoderm of *Polyporus sacer* are thick-walled, nodose-septate hyphae which arise from the upper parts of a layer of agglutinated, thick-walled, nodose-septate hyphae and fibre hyphae. Furthermore, the binding hyphae in the pileus of *Polyporus sacer* have fairly long flexuous, tapering branches while those of *Polyporus versicolor* has short, tortuous branches. These differences in the nature of the trichoderm and the character of the binding hyphae together with the presence of an orbicular pileus borne on a well differentiated stipe arising from a hypogeous sclerotium, must separate *Polyporus sacer* from *Polyporus versicolor* at the generic level.

Differences between *Polyporus sacer* and *Daedalea confragosa* are of a similar nature to those between *Polyporus sacer* and *Polyporus versicolor*. The cultural characters and fruit-bodies of *Fomes scutellatus* could not be included in the present study.

The fruit-bodies of *Polyporus sacer* possess a combination of hyphal and morphological characters that have not been found in any other species till now. Its relationships and systematic position cannot be determined at present but future studies of more species of poroid Hymenomycetes may confirm Fries' idea of a taxon typified by *Polyporus sacer*.

6. DISCUSSION

The object of this study was to determine to what extent the structures formed in cultures of poroid Hymenomycetes are also present in their carpophores in order to determine whether their carpophores reveal the same relationships as their cultures. From the descriptions of cultural and carpophore characters of the species studied, it is evident that the structures formed in cultures are mostly present in the carpophores but that certain exceptions and discrepancies were observed. These concerned the different types of hyphae and hyphal modifications.

In all the species studied, nodose-septate hyphae were found to be present in both the cultures and carpophores of all specimens examined, but in some species the nodose-septate hyphae became thick-walled. In *Polyporus dichrous*, *Polyporus adustus* and *Polyporus subiculoides* these thick-walled, nodose-septate hyphae make up the bulk of the carpophore tissues although they are rarely found in the cultures. In other species, e.g. *Polyporus versicolor* and *Lenzites sepiaria*, thick-walled as well as thin-walled, nodose-septate hyphae were present in both the cultures and carpophores. In still other species, e.g. *Trametes cingulata* and *Polyporus occidentalis*, thick-walled, nodose-septate hyphae were never seen in the cultures or carpophores. It therefore appears that in some species the nodose-septate hyphae may be modified by thickening of their walls, under conditions

prevailing in the formation of fruit-bodies; but hyphae modified in this way were not present in all the species in which thin-walled, nodose-septate hyphae were present in both cultures and carpophores. It thus appears that the modification or differentiation of thin-walled, nodose-septate hyphae into thick-walled, nodose-septate hyphae or "sclerified generative hyphae" (Donk, 1964) can occur in certain species only. This character must therefore be recognized and these hyphae must be regarded as a distinct type of hypha. Their presence or absence in carpophores must therefore be taken into consideration in studies involving hyphal characters of fruit-bodies.

In the species studied in Group 25, another type of nodose-septate hypha of which the walls are irregularly thickened, were shown to be present in both the carpophores and cultures. These species were also shown to have other carpophore characters in common which would allow their inclusion in one genus. Nobles (1958 b) showed that a number of species, in which this type of hypha is present in their cultures, also have other hyphal and basidiospore characters in common which allow their inclusion in Group 25. These nodose-septate hyphae with irregularly thickened walls are present in certain species only so that it is clear that this character must be genetically constant. For these reasons, nodose-septate hyphae with irregularly thickened walls must be regarded as constituting a morphologically distinct type of hypha and should be recognized as such in studies involving hyphal characters of fruit-bodies. It is well-known that these hyphae are often found with difficulty in fruit-bodies of species in which they are present in cultures but they cannot be ignored for this reason. Careful search in parts where fibre hyphae are not numerous, will usually reveal their presence.

In those species in which fibre hyphae were present in cultures, fibre hyphae also occurred in their carpophores but differences in morphology of the fibre hyphae were noticed in some cases. In general, these differences were observed mainly in the extent of branching of the fibre hyphae and in their diameter. In *Daedalea confragosa* it was seen that the fibre hyphae in cultures were of one kind only, viz. narrow and branched with long branches while the fibre hyphae in the carpophores were either unbranched or had numerous short, twisted branches. In most species included in Group 45, with the exception of *Polyporus vinosus,* the fibre hyphae of the carpophores consist of unbranched skeletal hyphae and of binding hyphae with numerous, short, tortuous branches (sensu Corner, 1932 a, b); but the fibre hyphae of their cultures are mainly unbranched whilst some fibre hyphae have a number of fairly long branches, often fairly straight. In other species, mainly those of Group 25, where short-branched binding hyphae were not present in the carpophores, the fibre hyphae of the cultures were also mostly unbranched or had an occasional long branch. It can be concluded, however, that the fibre hyphae of the carpophores of all the species included in this study, agree with those of the fibre hyphae of the carpophores.

In cultures of *Polyporus versicolor, Polyporus pubescens, Trametes acupunctata* and *Trametes corrugata* a network of very narrow, dichotomously branched hyphae were observed in very tough parts of the mycelial mat. These hyphae, which were less than 1.0μ in diameter, could not be traced to their origin and were just barely discernible under the oil immersion lens. Such hyphae had been reported by Nobles (1965) in cultures of *Polyporus versicolor* and *Polyporus pubescens* but their presence in carpophores had not been reported by other workers. In this study they have been found only in the tissues of carpophores of two collections of *Trametes corrugata* including the carpophores of the type specimen of *Earliella.* Since these hyphae are so narrow and inconspicuous, their nature could not be determined and because the tissues are torn apart with needles,

to dissect out the different types of hyphae, they are subject to destruction because of their dichotomous branching habit. Small pieces may easily be overlooked as debris which is often present in the mounts; but their presence in the two carpophores indicate that such hyphae may also be present in carpophores of species in which they are formed in culture. The very tough nature of those parts of the mat in which these hyphae are present, suggests that these hyphae may serve as binding hyphae in the tissues.

In the five species studied in Group 51 and Group 53, nodose-septate hyphae of which the terminal portions were differentiated into cuticular cells or irregular projections, were present in the cultures. The cuticular cells were usually well-developed, mostly with thin walls and present in large numbers. In the carpophores, however, these structures were either not easily seen or were absent. Of the large number of carpophores of *Daedalea confragosa* that were examined, cuticular cells could be found in two only and they were smaller than those of the cultures. In the cultures of *Hexagona tenuis* and *Trametes acupunctata* the cuticular cells were well-developed but in their carpophores the corresponding structures did not resemble cuticular cells. Instead they resembled the "hyphae with irregular thick-walled branches, nodules or protuberances" described by Nobles (1965) under Code Symbol 11. Similar hyphae were also present in the cultures of *Daedalea confragosa, Hexagona tenuis, Trametes acupunctata* and *Trametes corrugata* as well as in their carpophores where they were present as the only specialized cuticular structures. Therefore, it seems that "cuticular cells" and "hyphae with irregular thick-walled branches, nodules or protuberences" are different manifestations of the same hyphal modification which develop under different conditions of growth. These structures, which form dark-coloured patches over the older part of the upper surface of the carpophores, occurred sporadically on the carpophores. They were often absent from some carpophores but present on others in the same collection. Because they are formed more frequently and regularly in cultures than in carpophores, it appears that their formation is influenced by the conditions of growth of the relevant mycelia. Their more regular presence in cultures of various species is thus of greater value in the recognition of cultures than in the identification and classification of the carpophores of these species.

Fructifications which produce fertile basidia and basidiospores were formed by a number of species in cultures. In every case the basidia and basidiospores were identical in respect of dimensions and morphology to those of the carpophores found in nature. This confirms the statements by Teixeira (1962 b) and Kotlaba (1964) that the characters of the basidia and basidiospores are fixed and constant for each species and emphasizes the great taxonomic importance accorded to these structures by all workers.

An interesting aspect of the formation of fructifications in culture is the fact that basidia and spores may be borne on structures which bear no resemblance to the corresponding fruit-bodies formed in nature. Further, the fructifications formed in cultures were seen to develop in distinctly different ways. In *Daedalea* spp. the fertile areas consisted of irregular, low, anastomosing ridges which grew out from the areas of compact mycelium. In *Fomes cajanderi* the fruiting areas developed as gradually deepening tubes in areas of felty mycelia. In *Lenzites trabea* flat, antler-like processes which united laterally to form large tubes, grew out of the mat. In *Polyporus versicolor, Polyporus occidentalis, Trametes meyenii* and some other trametoid species in Group 45, thin, acicular spines developed from felty patches and gradually widened into flat processes which united laterally to form tubes. These different ways of formation of fertile spore-bearing tubes,

occurred in cultures which differed in cultural characters. These observations thus indicate that these different ways of formation of spore-bearing tubes may represent phylogenetic differences between the species concerned. This conclusion is supported by the fact that differences in hyphal and anatomical characters were shown to exist between the carpophores of the various species in which fructifications formed in cultures. It is further supported by the fact that differences in the method of pore formation are known to occur in carpophores of different species under natural conditions (Ames, 1913; Corner, 1953). Savile (1955), suggested that ontogenic studies may throw light on the origins of tubes of various types of Hymenomycetes; but careful observations on fruit-body formation in culture and in nature of a large number of species will have to be made before practical use can be made of such observations in the taxonomy and phylogeny of these fungi.

From the above it is thus evident that the structures formed in cultures of Hymenomycetes are usually also present in the fruit-bodies from which they were made, although some exceptions to this general rule were encountered and certain structures were not quite identical in the cultures and in carpophores. This conclusion agrees with the statement by Pinto-Lopes (1952) and the results of work of Sarkar (1959), Davidson, Lentz & McKay (1960), McKay & Lentz (1960), Weresub & Gibson (1960), Nobles & Frew (1962) and Lombard & Gilbertson (1965, 1966). Consequently, the carpophores of the different species studied here can also be assigned to the same groups as the cultures made from them. The relationships between the carpophores of the different species as indicated by their cultures must be examined now.

In all those groups in which more than one species was studied, it was found that although the carpophores displayed the characters which allow their inclusion in the group, differences in the morphological characters of the hyphae and construction of the carpophores were present between the individual species or between smaller groups of species within the group. So it was shown that carpophores of *Lenzites trabea* with dimitic fruit-bodies (sensu Corner, 1932 a) differ from those of *Lenzites sepiaria* with trimitic fruit-bodies (sensu Corner) although both are included in Group 13. Of the four species studied in Group 25, the carpophores of *Daedalea quercina* and *Trametes moesta* are identical in hyphal characters but differ only in small morphological characters. The other two species, *Trametes roseola* and *Fomes cajanderi,* reveal similar micromorphological characters but differ from the two *Daedalea* spp. in respect of carpophore colour, texture and the presence of poroid hymenia. Despite these differences, which appear to be of interspecific importance only, it was suggested that these two species should be included in the genus *Daedalea* Fr. In Group 45, *Polyporus vinosus* differs from the *Coriolus* — *Lenzites* — *Trametes* spp. by the absence of binding hyphae from its carpophores. Among the other species in Group 45 a smaller group in which "sclerified generative hyphae" (Donk, 1964) are not present and another group in which "arboriform skeletal hyphae" (Teixeira, 1962 b) are present in the carpophores, could be distinguished. The four species in Group 51 have in common the presence of nodose-septate hyphae, fibre hyphae and cuticular cells in their cultures and their carpophores. They were found to differ widely in respect of carpophore construction, carpophore morphology and hyphal characters. Such differences are held to be sufficiently important to regard the relevant fungi as species of separate and distinct genera. Inclusion of some species in certain groups thus appears to depend on the presence of common characters which arose though convergent evolution (Savile, 1954, 1955) whilst other species may be grouped together because they are related through many common characters in respect of the morphology of their hyphae and other

microstructures and construction of their carpophores. These observations thus support Nobles' (1958 b) suggestion that her groups may constitute taxa of generic or higher rank but that some groups may be entirely artificial.

The characters that should be taken into account when considering affinities at generic level in the polypores have not been clearly enumerated as yet and the problem of delimitation of genera of the Hymenomycetes has developed as the most important aspect of their taxonomy. A number of workers including Corner (1948), Wakefield (1948), Pinto-Lopes (1952), Cunningham (1954) and Teixeira (1962 b) regard spore characters, and micromorphology and anatomy of carpophores as the most important indicators of generic affinities although Teston (1953 a) and Smith (1966) are rather sceptical. The views of the first-named workers are summarized by Kotlaba (1964) who stated that "the importance of these characters lie in their particular combinations." He admitted that a particular character may have different taxonomic values in different groups and that no generalizations can be made. He also considered a complex of characters to be the basis necessary for delimitation of genera. The problem thus evolves as the need to determine the relative values of various characters available for taxonomic purposes; but these relative values can be determined only after careful observations on a very large number of species had been made. Such observations had been made on a relatively small number of species only. The number of species included in the present study is insufficient to allow delimitation of genera but the observations made on them serve to emphasize some aspects of carpophore anatomy and micromorphology of hyphae and other structures, that should be taken into consideration in taxonomic studies of these fungi.

With the introduction of the concept of hyphal systems, Corner (1932 a, b) made available useful terminology to describe the construction of carpophores of macrofungi. This concept had been applied to the study of various groups of Hymenomycetes but without further extension or definition of hyphal types or attempts at finer distinctions in hyphal morphology except by Teixeira (1956, 1962 b), who described different kinds of skeletal hyphae. No attempts had been made to describe differences in carpophore construction in polypores, comparable to the different types of texture of carpophore of resupinate Hymenomycetes as defined by Talbot (1954 a), but the existence of similar differences is evident from the above descriptions of the carpophores. The carpophores of *Polyporus dichrous, Polyporus adustus* and *Polyporus subiculoides* consist entirely of nodose-septate hyphae. These carpophores thus have monomitic hyphal systems as defined by Corner (1932 a, b), Cunningham (1946, 1954) and Teixeira (1962 b). It is, however, evident from the descriptions that thin-walled, nodose-septate hyphae and thick-walled, nodose-septate hyphae are present in different amounts in carpophores of those species. It is further evident from the descriptions that the thick-walled, nodose-septate hyphae occur in definite regions of the carpophores and that they may be orientated in different directions in the tissues. These differences result in differences in complexity of construction and of texture of the carpophores. They are even more strikingly evident when the carpophores of these three species are compared with carpophores of some species of *Peniophora* and *Corticium,* with monomitic hyphal systems which consist of branched, thin-walled, nodose-septate hyphae terminating in clusters of basidia (Slysh, 1960); Cunningham, 1963; Talbot, 1951, 1954 a, 1958 b). It is thus clear that differences in carpophore construction and hyphal characters can exist in carpophores with monomitic hyphal systems and that these differences are neither recognized nor conveyed by the expression "monomitic hyphal system." Characters of carpophore construction, hyphal orientation and hyphal morphology observed in these species

are constant for each species and genetically fixed. They are therefore of phylogenetic importance. Furthermore, it had been shown that the thick-walled, nodose-septate hyphae, of which several types have been described, must be regarded as morphologically distinct from thin-walled, nodose-septate hyphae. Therefore, the presence or absence of thick-walled septate hyphae in carpophores, the relative position of the different types of septate hyphae, and their orientation in the carpophores must be considered in taxonomic studies and expressed in suitably descriptive terms which can convey characteristic types of construction of carpophores with "monomitic hyphal systems." In this way generic affinities may become more clearly apparent than is the case at present.

In species with carpophores with dimitic hyphal systems in Corner's (1932 a, b) terminology, similar differences in construction and hyphal characters exist. In carpopohres of *Lenzites trabea,* branched, thick-walled, nodose-septate hyphae which seem to form a primitive and poorly developed binding hyphal system are present besides the thin-walled, nodose-septate hyphae and fibre hyphae. In the carpophores of *Daedalea quercina, Daedalea moesta, Trametes roseola* and *Fomes cajanderi,* nodose-septate hyphae with irregularly thickened walls are present besides the thin-walled, nodose-septate hyphae and fibre hyphae. These different types of hyphal differentiation contrast strongly with that of the carpophores of *Fomes pinicola* where only thin-walled nodose-septate hyphae and fibre hyphae are present. They also differ from those of carpophores of *Trametes acupunctata* where some nodose-septate hyphae are differentiated into hyphae with irregular projections and cuticular cells. In carpophores of *Polyporus vinosus* some of the thin-walled, nodose-septate hyphae become thick-walled, turn brown and bind the fibre hyphae into a dense tissue. Yet, despite the morphological differences found in the nodose-septate hyphae they are regarded as generative hyphae by Corner (1932 a, b) and other workers and all these species are regarded as having dimitic hyphal systems. It is thus evident that differences in hyphal characters and carpophore construction of a similar nature to those found among species with carpophores consisting of nodose-septate hyphae only, are also present among species of which the carpophores consist of nodose-septate hyphae and aseptate fibre hyphae. These differences in carpophore construction and hyphal characters were also found to be fixed and constant for the different species. They are thus genetically constant and therefore of phylogenetic importance. Their presence in carpophores must therefore be recognized and taken into consideration when affinities at the generic level are being considered as had been done by Lentz (1960) with *Lopharia crassa* and *Lopharia cinerascens;* but these differences in carpophore construction and hyphal morphology of species whose carpophores have "dimitic hyphal systems" are not apparent from this expression.

Corner (1932 a, b; 1953), Kotlaba & Pouzar (1957) and Teixeira (1962 b) regard species of Polyporaceae having carpophores constructed of generative hyphae, skeletal hyphae and binding hyphae as the most highly evolved group of species in this family. All the species included in the present study in Group 45, Group 51 and Group 53 with the exception of *Polyporus vinosus* and *Trametes acupunctata* respectively, have carpophores of this type with trimitic hyphal systems (sensu Corner, 1932 a, b); but differences in hyphal morphology and carpophore construction similar in many respects to those found in carpophores of species with monomitic and dimitic hyphal systems, were also found to exist among carpophores of these species. In these species too, the modified nodose-septate hyphae are considered to be important because of their different forms in carpophores of different species. In carpophores of some species e.g. *Trametes cingulata* and *Polyporus occidentalis* the nodose-septate hyphae were consistently thin-walled. In others, e.g. *Lenzites betulina* and *Polyporus versicolor,* nodose-septate hyphae

with thick walls were present in the context as more or less straight, branching hyphae, parallel to the fibre hyphae, while in some other species, e.g. *Polyporus versicolor* and *Lenzites palisoti*, thick-walled, nodose-septate hyphae contributed to the binding hyphal system of the carpophores. These hyphae resemble the aseptate binding hyphae but are recognizable by the presence of clamp connections. In some carpophores of species in Group 51, terminal cells of nodose-septate hyphae are differentiated into cuticular cells or brown, thick-walled hyphae with irregular projections, whilst in Group 53, thick-walled, nodose-septate hyphae formed the hairy upper surface of the carpophores of *Polyporus sacer*. There are thus differences in the morphology and function of these hyphae in carpophores of different species and even in different parts of the same carpophore of some species.

Teixeira (1956, 1962 b) showed that different types of skeletal hyphae were present in carpophores of different species with trimitic hyphal systems. Although the skeletal hyphae found in the species mentioned above were mainly unbranched, corresponding to Teixeira's "vermiculiform skeletal hyphae" (Teixeira, 1962 b), fibre hyphae with one to three branches towards the distal end were found in carpophores of some species with trimitic hyphal systems in this study. These branches were found to contribute to the binding hyphal system of the carpophores. Morphologically they appear to correspond to Teixeira's (1956, 1962 b) "arboriform skeletal hyphae," but Furtado (1966) maintained that "arboriform skeletal hyphae" are found only in carpophores of Ganodermoid species. From observations made in this study, however, it appears that they may also occur in carpophores of species of *Trametes* and *Coriolus*. Differences in the morphology of fibre or skeletal hyphae thus occur and must be taken into consideration in taxonomic studies of these fungi. Differences in the binding hyphae of different species or groups of species were also evident. Cunningham (1946) recognized two types, viz.: the "bovista" type and the "long" type of binding hypha but failed to distinguish adequately between them. Morphological differences between binding hyphae of different species were observed in the species studied here. In some species of *Trametes* and *Coriolus* the binding hyphae were found to be rather intricately branched structures with the branches short, thick, often tortuous and of a different refractive index from that of the skeletal hyphae. In other species, e.g. *Trametes cingulata, Polyporus occidentalis* and *Polyporus sacer* the binding hyphae resemble skeletal hyphae but have fairly long, flexuous, tapering branches. The length and form of branches of binding hyphae may vary according to their position in the carpophore but differences in morphology of the branches and the difference in refractive index may be observed with little difficulty.

Corner (1953) described the binding hyphae from the carpophores of *Polyporus sulphureus* and *Polyporus squamosus*, species which he regarded as having dimitic hyphal systems with generative and binding hyphae. In both these species, the binding hyphae are formed by the evagination of the walls of intercalary cells of generative hyphae into a number of tortuous, lateral processes which later become thick-walled. Structures which bear some resemblance to these were seen in cultures and carpophores of *Lenzites sepiaria* and in the carpophores of *Polyporus adustus* (Fig. 2 p), but these structures, which have a binding function in the carpophores, do not arise in the same way as the binding hyphae which originate and develop as the terminal cells of lateral branches of generative hyphae. These structures are not separated from the parent cells by septa. For this reason these structures should be regarded as binding processes rather than binding hyphae. Differences in morphology and ontogeny of the elements of the binding hyphal system thus exist and should be of great value in taxonomic studies of Polyporaceae.

From the above it is thus evident that numerous differences in the morphology and ontogeny of the hyphae which comprise the different hyphal systems exist

in carpophores of different species. The different types of hyphae, their morphology, occurrence and function in fruit-bodies of polypores in the present study may be summarized as follows:—

1. *Septate hyphae*

1.1 Thin-walled, nodose-septate hyphae; branching, mostly with deeply staining contents; present in the growing regions of the upper surface, margin and hymenial surfaces; giving rise to all other structures in the carpophore, (generative hyphae, Corner, 1932 a, b); collapsed and empty in older parts of carpophores of some species.

1.2 Thick-walled, nodose-septate hyphae; walls regularly thickened, with or without staining contents, regularly septate, branching, (sclerified generative hyphae, Donk, 1964) occur as:

(i) hyphae supporting reflexed pilei and constituting major or only hyphal type, orientated mainly parallel to direction of growth of pileus;

(ii) hyphae as in (i) but present in small numbers in context, among fibre hyphae in species where these are present; function unknown;

(iii) hyphae with tortuous branches orientated across the direction of growth of the pileus and assisting in binding the tissues;

(iv) hyphae supporting pilei as in (i) but forming lateral, branched, binding processes;

(v) short, thick-walled or solid hyphae forming "hairs" of tomentose upper surface of pilei.

1.3 Nodose-septate hyphae with irregularly thickened walls, present in lower parts of context of certain species; function unknown.

1.4 Hyphae with irregular projections and cuticular cells; brownish, thick-walled elements arising from septate hyphae, present in dark-coloured incrusted areas over the older parts of some carpophores of certain species; function unknown, probably protective.

2. *Fibre hyphae*

2.1. Unbranched, straight or somewhat flexuous, hyaline to pale brown, thick-walled or sub-solid to solid, aseptate or with one or two simple septa towards the apex, arising from thin-walled or thick-walled regularly septate hyphae; when present, constituting bulk of tissues of carpophore, terminating in context or at upper surface and margin or below hymenial surfaces; arranged parallel to direction of growth of carpophore; supporting and protecting hymenophore and forming tomentum or pubescence or, by agglutination with lacquer-like material, incrusted or fibrillar or glabrous upper surface. (Aciculiform and vermiculiform skeletal hyphae, Teixeira 1956, 1962 b).

2.2 Branched fibre hyphae, as in 2.1 but with one to three branches towards the apex; the main stem parallel to the direction of growth of the carpophore and supporting the carpophore tissues, the branches arranged across the direction of growth of the carpophore and binding the tissues; occurs in lower context of certain species (arboriform skeletal hyphae, Teixeira 1956, 1962 b).

2.3 Branched fibre hyphae, the branches long and tapering, otherwise as in 2.1 branches interwoven with other hyphae across the direction of growth of the carpophore; bind hyphae into tough tissues; present in context of some species in which unbranched fibre hyphae are also present.

2.4 Branched fibre hyphae with numerous short tortuous branches, interwoven with other fibre hyphae across the direction of growth of the carpophores, otherwise as in 2.3.

2.5 Dichotomously branched, very narrow hyphae, forming a network in the lower context tissues of some species; apparently aseptate, origin and function unknown.

This list is by no means complete as many types of hyphae, such as simple-septate, thin-walled, generative hyphae (Corner, 1932 b), thick-walled, simple-septate hyphae (Pinto-Lopes, 1952), inflated hyphae (Corner, 1953) and others were not encountered in the carpophores of the species included in this study. It does however serve to illustrate the diversity in hyphal morphology and hyphal function which exists in carpophores of the poroid Hymenomycetes. It is evident from this, that this diversity and its possible phylogenetic connotations had not been fully utilized in taxonomic studies of these fungi. It is also evident that this diversity in hyphal morphology and function together with the resulting differences in carpophore construction and texture, are not adequately expressed and conveyed by the concept of hyphal systems. Consequently, the concept of hyphal systems had been criticized by Pinto-Lopes (1952), Teston (1953 a), Welden (1960), Smith (1966) and others.

Bondartzeva (1963) and Smith (1966) expressed the view that hyphal systems are indications of adaptive evolution and devices to restrict waterloss from the carpophores and prevent dessication and damage to the hymenium. Undoubtedly, there is strong evidence in favour of these views. Savile (1954, 1955) stated that if an ecological niche exists, it will be filled repeatedly by different organisms which find similar ways to achieve this. Problems involved in the extension of the hymenial surface, protection of the hymenial surface from rain and reduction of loss of moisture from fruit-bodies of Hymenomycetes can be overcome in a limited number of ways only so that similar structures must have developed repeatedly. It is thus conceivable that species of which fruit-bodies have similar hyphal systems (sensu Corner, 1932 a, b) may have developed repeatedly and independently. For these reasons species having similar hyphal systems cannot be regarded as being congeneric on that basis only. Indeed, it became evident in this study that important differences in morphological characters of the hyphae and in their arrangement and function in the carpophores can exist in different species with similar hyphal systems. It is, however, also evident from this study that the hyphae present in fruit-bodies of individual species are morphologically and genetically constant for each species unlike such characters as, habit, insertion, hymenial configuration and texture of the upper surface of the carpophores. It also became evident that the hyphal complement and construction of the fruit-bodies, i.e. the placing of different types of hypha in the carpophores of different species, are constant for each species although certain specialized structures, such as cuticular cells, may be absent from carpophores of species which are capable of forming them. For this reason these characters should be studied and recorded in detail in descriptions of carpophores of different species. All these characters must be considered together with other constant characters, such as spore shape and size and basidial shape and size, in the delimination and characterization of genera of the polypores. Applied in this way these characters become valuable components of the "complex of characters" which must be considered for generic delimination as stated by Ames (1913), Wakefield (1948), Pinto-Lopes (1952), Nobles (1958 b), Teixeira (1962 b) and Kotlaba (1964) among others; but careful observation and accurate descriptions of hyphal characters and construction of carpophores rather than generalizations by means of collective terms are essential prerequisites for their use in this connection.

7. SUMMARY

1. Twenty-four species of poroid Hymenomycetes from South Africa and Canada were studied. Of these, twelve species occur in South Africa, four in Canada whilst eight are found in both countries.

2. The micromorphological characters and oxidase reactions of the cultures and the micromorphological characters and construction of the carpophores together with the type of decay and host range of these twenty-four fungi were studied in order to determine: (i) which microstructures are formed in cultures of these species; (ii) their relationships as indicated by their cultural characters; (iii) whether the structures formed in culture are also present in their carpophores, and (iv) whether the relationships indicated by cultural characters are also revealed by their carpophores.

3. Mycelia obtained from single basidiospores were paired in culture in order to determine the type of interfertility of certain species or to determine conspecificity between different collections. In some species attempts were made to dikaryotize large haploid mycelia by pairing them with small dikaryotic mycelia in culture in order to establish conspecificity between the different collections from which the mycelia were obtained.

4. The literature on the classification of the poroid Hymenomycetes, the structure and anatomy of their carpophores in relation to their taxonomy and studies of Hymenomycetes in pure culture, was reviewed.

5. The cultural characters were studied by observations on cultures of the fungi incubated in the dark on 1.5 per cent malt agar plates for a period of six weeks according to the methods of Nobles (1948). Construction and micromorphology of the carpophores were studied by teasing apart thick sections of carpophores to obtain undamaged structures for examination according to the methods of Teixeira (1956). All microstructures were examined by means of the oil immersion lens and recorded by means of camera lucida drawings or photomicrographs.

6. It was found that the 24 species were distributed among nine of the 36 groups proposed by Nobles on the basis of their cultural characters. In five of these groups only one species was studied in each. Two of these species, *Polyporus dichrous* in Group 9 and *Polyporus subiculoides* in Group 32 displayed characters that made inclusion in their respective groups somewhat dubious.

7. The structures formed in cultures of the different species were also found in their carpophores with the exception of chlamydospores. Although chlamydospores were present in cultures of most species they were found in carpophores of one species only, *Fomes pinicola*.

8. As the structures formed in cultures are also present in the carpophores of the different species, the carpophores can be placed in the same groups as the cultures but do not show the same relationships.

9. Differences in the micromorphological characters of the hyphae and in the types of hyphae present in the carpophores of species from the same group were found in species of three of the four groups in which more than one species was studied.

10. Differences in construction of the carpophores and orientation and functions of their hyphae were observed in carpophores of species in which similar types of hyphae are present.

11. Important differences between the hyphal characters and construction of the carpophores of various species and the carpophores of type species of genera to which they have been assigned by different authors, were demonstrated.

12. Differences in the characters and origin of the "hairs" that constitute the trichocutis or upper surfaces of carpophores of a number of species, were noted.

13. Cuticular cells which characterize cultures of *Daedalea confragosa, Trametes corrugata, Trametes acupunctata* and *Hexagona tenuis*, are often lacking from individual fruit-bodies of these different species or are present as hyphae with irregular projections on the carpophores. Because of their sporadic appearance on carpophores, these structures are not regarded as being reliable characters for taxonomic purposes.

14. Three different ways of development of fruiting structures were observed in cultures of the various species, viz.: (i) formation of low anastomising ridges; (ii) tubules and (iii) erect acicular or flattened spines. These are considered to be of phylogenetic importance.

15. The type of interfertility of seven species was determined. All displayed the tetrapolar type of interfertility. Of these, *Polyporus dichrous* only, is associated with brown rot and its cultures do not produce extra-cellular oxidase enzymes. The other six species are associated with white rots and their cultures produce extra-cellular oxidase enzymes.

16. By pairing haploid mycelia derived from single basidiospores from different collections, it was found that haploid mycelia from a South African collection of *Lenzites trabea* were completely compatible with haploid mycelia from a Canadian collection. The conspecificity of the two collections were thus confirmed. The conspecificity of four collections of *Trametes cingulata* from South Africa were also confirmed by means of this technique. When this technique was used to determine the conspecificity of a South African collection of *Polyporus adustus* with Canadian collections of this species it was found that only a very low degree of compatibility existed between the haploid mycelia from the South African and Canadian collections although no differences in cultural and carpophore characters could be found.

17. The technique of dikaryotizing a large haploid mycelium grown in culture by pairing it with a small dikaryotic mycelium was used to confirm the identity of different collections of four different species. This was successful with four collections of *Trametes meyenii* and four collections of *Polyporus occidentalis*. This method failed however with five collections of *Polyporus dichrous* and seven collections of *Polyporus pubescens*.

18. It was concluded that the micromorphological characters of the hyphae and other microstructures as well as the construction of the carpophores are constant for each species. All these characters should be carefully described and recorded for each species and should be taken into consideration in taxonomic studies of these fungi. Differences and similarity of micromorphological characters and construction of carpophores of species are not adequately conveyed by the concept of hyphal systems.

8. TABLES

TABLE 1. — Oxidase reactions and colony diameter (in mm) of different isolates of *Polyporus adustus* on malt-gallic acid medium and malt-tannic acid medium and oxidase reaction as indicated by gum guaiac solution applied directly to cultures on malt agar, after 14 days' incubation.

Isolate No.	Oxidase reaction			Colony diameter (mm)	
	Gum guaiac	Gallic acid	Tannic acid	Gallic acid	Tannic acid
DOAM 9209	+ (1)	—	+	trace	trace
DAOM 17571	— (2)	—	—	trace	no growth
DAOM 17575	—	—	—	5	no growth
DAOM 22576	—	—	+	5	no growth
DAOM 53500	+	—	+	trace	trace
PRE 42039	++(3)	—	—	12	no growth
PRE 42328	—	—	—	12	no growth
PRE 42332	+	+	—	10	no growth
PRE 42350	+	—	—	15	trace
PRE 42365	—	—	—	trace	none

(1) Positive reaction;

(2) Negative reaction;

(3) Strong positive reaction.

TABLE 2.— Results of pairing four mycelia derived from single basidiospores of a South African collection, PRE 42039, with single basidiospore cultures of each of four Canadian collections PRE 42365, PRE 42328, PRE 42329 and DAOM 53500, of *Polyporus adustus.*

		PRE 42039				PRE 42365				PRE 42328				PRE 42329				DAOM 53500			
		1	2	1	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
PRE 42039	1					—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	2					—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	3					—	—	—	—	—	—	—	—	—	—	+	—	—	—	—	—
	4					—	—	—	—	—	—	—	—	—	+	—	+	—	—	—	—
PRE 42365	1	—	—	—	—					+	+	+	+	+	+	+	+	+	+	+	+
	2	—	—	—	—					+	+	+	+	+	+	+	+	+	+	+	+
	3	—	—	—	—					+	+	+	+	+	—	+	+	+	+	+	+
	4	—	—	—	—					+	+	+	+	+	+	+	+	+	+	+	+
PRE 42328	1	—	—	—	—	+	+	+	+					+	+	+	+	+	+	+	+
	2	—	—	—	—	+	+	+	+					+	+	+	+	+	+	+	+
	3	—	—	—	—	+	+	+	+					+	+	+	+	+	+	+	+
	4	—	—	—	—	+	+	+	+					+	+	+	+	+	+	+	+
PRE 42329	1	—	—	—	—	+	+	+	+	+	+	+	+					+	+	+	+
	2	—	—	—	—	+	+	+	—	+	+	+	+					+	+	+	+
	3	—	—	+	—	+	+	+	+	+	+	+	+					+	+	+	+
	4	—	+	—	+	+	+	+	+	+	+	+	+					+	+	+	+
DAOM 53500	1	—	—	—	—	+	+	+	+	+	+	+	+	+	+	+	+				
	2	—	—	—	—	+	+	+	+	+	+	+	+	+	+	+	+				
	3	—	—	—	—	+	+	+	+	+	+	+	+	+	+	+	+				
	4	—	—	—	—	+	+	+	+	+	+	+	+	+	+	+	+				

A (+) indicates formation of clamps on the mycelium.

TABLE 3. — Mating types of mycelia from single spores of *Polyporus dichrous* PRE 42384.

A_1 B_1: 1, 5, 10, 12; A_1 B_2: 3, 8, 13, 15, 18;
A_2 B_2: 2, 7, 9, 11, 16, 17; A_2 B_1: 4, 14.

TABLE 4. — Results, showing the formation of clamp connections (+), when four single basidiospore cultures from each of two isolates of *Lenzites trabea,* PRE 42457 and DAOM 72285, were paired in all possible combinations.

		PRE 42457			
		1	2	3	4
DAOM 72285	1	+	+	+	+
	2	+	+	+	+
	3	+	+	+	+
	4	+	+	+	+

TABLE 5. — Collections of *Polyporus pubescens* tested for conspecificity with monospore cultures Nos. 5 and 8 of *Polyporus pubescens* DAOM 94039.

DAOM 17577	DAOM 94017
DAOM 52833	DAOM 94026
DAOM 53503	DAOM 94039
DAOM 73309	

TABLE 6. – Mating types of single spores of *Trametes meyenii* PRE 42446.

A_1 B_1: 1, 9; A_2 B_1: 3, 4, 5, 12, 13, 15;
A_1 B_2: 11, 16; A_2 B_2: 2, 6, 7, 8, 10, 14.

TABLE 7. — Mating types of single spores of *Lenzites palisoti* PRE 42442.

A_1 B_1: 4, 5, 11, 15; A_1 B_2: 8, 10;
A_2 B_2: 12, 13, 16; A_2 B_1: 6, 9.
No mating: 1, 2, 3, 7, 14.

TABLE 8. — Mating types of mycelia from 16 single spores of *Polyporus occidentalis* PRE 42863.

A_1 B_1: 1, 2, 3, 11, 12, 15; A_1 B_2: 4, 6, 16;
A_2 B_1: 5, 7, 13; A_2 B_2: 8, 9, 10, 14, 16.

TABLE 9. — Mating types of single basidiospores of *Trametes cingulata* Berk. PRE 42448.

A_1 B_1: 1, 9, 11, 14, 15, 16; A_1 B_2: 3, 4, 5, 8, 10, 12, 13;
A_2 B_2: 6, 7; A_2 B_1: 2.

TABLE 10. — Mating types of single spore of *Polyporus vinosus* PRE 42154.

A_1 B_1: 1, 7, 8, 9, 12, 13, 14; A_2 B_1: not present;
A_1 B_2: 2, 4, 5, 10, 15, 16; A_2 B_2: 3, 6, 11.

TABLE 11. — Distribution of mating types in 16 single spore cultures of *Trametes corrugata*, PRE 42454.

A_1 B_1: 2, 5, 7, 9, 16; A_1 B_2: 4, 12, 13;
A_2 B_2: 6, 10, 11, 14; A_2 B_1: 1, 3, 8, 15.

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Somatic Nuclear Division in Stemphylium botryosum

by

K. T. van Warmelo*

Abstract

Nuclear division in an isolate of *Stemphylium botryosum* obtained from lucerne was investigated using the HCl-Giemsa technique. Vegetative mycelium was predominantly monokaryotic. Chromosome counts at metaphase gave a tentative haploid number of six. Six chromosomes could again be distinguished at late anaphase. Migration of nuclei between hyphae was observed. The conclusion is drawn that somatic divisions in this fungus are strictly mitotic.

Introduction

This investigation on the somatic nuclear division in *Stemphylium botryosum* was undertaken to investigate the mechanism and regularity of genome replications at the divisions. This would give an indication of the possible degree of aneuploidy and the stability of specific genomes which could be useful in any future investigation of the pathogenicity of this fungus.

The genus *Stemphylium* is considered to be closely related to the genus *Alternaria* and a comparison of their respective chromosome numbers and sizes could perhaps demonstrate the closeness of this relationship.

Hartmann (1964) investigated nuclear divisions in *Alternaria tenuis* and found that these followed a typical mitotic sequence. The haploid chromosome number was determined as five.

Despite many early investigations on somatic divisions in fungi (Olive, 1953; Hrushovetz, 1956) it is only recently that close attention has been given to, and success attained with, the fine structure of dividing somatic fungal nuclei.

Several possible mechanisms of division have been put forward by workers on many different fungi. These have included amitosis (Bakerspigel, 1961, 1962; Robinow, 1957a, 1957b; Saksena, 1961), atypical mitosis by means of a nuclear filament (Dowding & Weijer, 1961; Dowding, 1966; Weijer & Weisberg, 1966) and a variant of mitosis (Aist & Wilson, 1967) the interpretation of which has since been modified (Aist & Wilson, 1968).

Typical mitosis has, in contrast, been found in different genera by different workers (Somers, Wagner & Hsu, 1960; Hall, 1963; Ward & Ciurysek, 1961, 1962; Hartmann, 1964; Rogers, 1965; Hosford & Gries, 1966; Shatla & Sinclair, 1966; Knox-Davies, 1966, 1967).

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Ward & Ciurysek (1962) summarised and discussed the various mechanisms of somatic division put forward by many different workers, both from the logical and from the factual point of view and concluded that ". . . the evidence . . . constitute strong grounds, therefore, for the conclusion that the somatic nuclei of fungi divide in the same manner as those of higher organisms."

Materials and Methods

The strain of *Stemphylium botryosum* used in this investigation was isolated from lucerne. The fungus was maintained on Difco malt agar. Best growth was obtained at 25°C while fairly satisfactory growth was seen at 16-17°C. Unfortunately, however, a noticeable decrease in sporulation vigour at each successive sub-culture occurred until all cultures were virtually sterile. Even transfers using conidia as inoculum failed to regenerate the original capacity for sporulation.

The nuclei were stained with the HCl-Giemsa stain used on a large number of fungi by many different workers (Hrushovetz, 1956; Ward & Ciurysek, 1961, 1962; Rogers, 1965; van Warmelo, 1966; Knox-Davies. 1966, 1967). Best results were obtained by taking blocks of agar and mycelium cut from a culture through the various solutions instead of using macerated air-dried mycelium (Ward & Ciurysek, 1962) or mycelium on Cellophane (Roane, 1952).

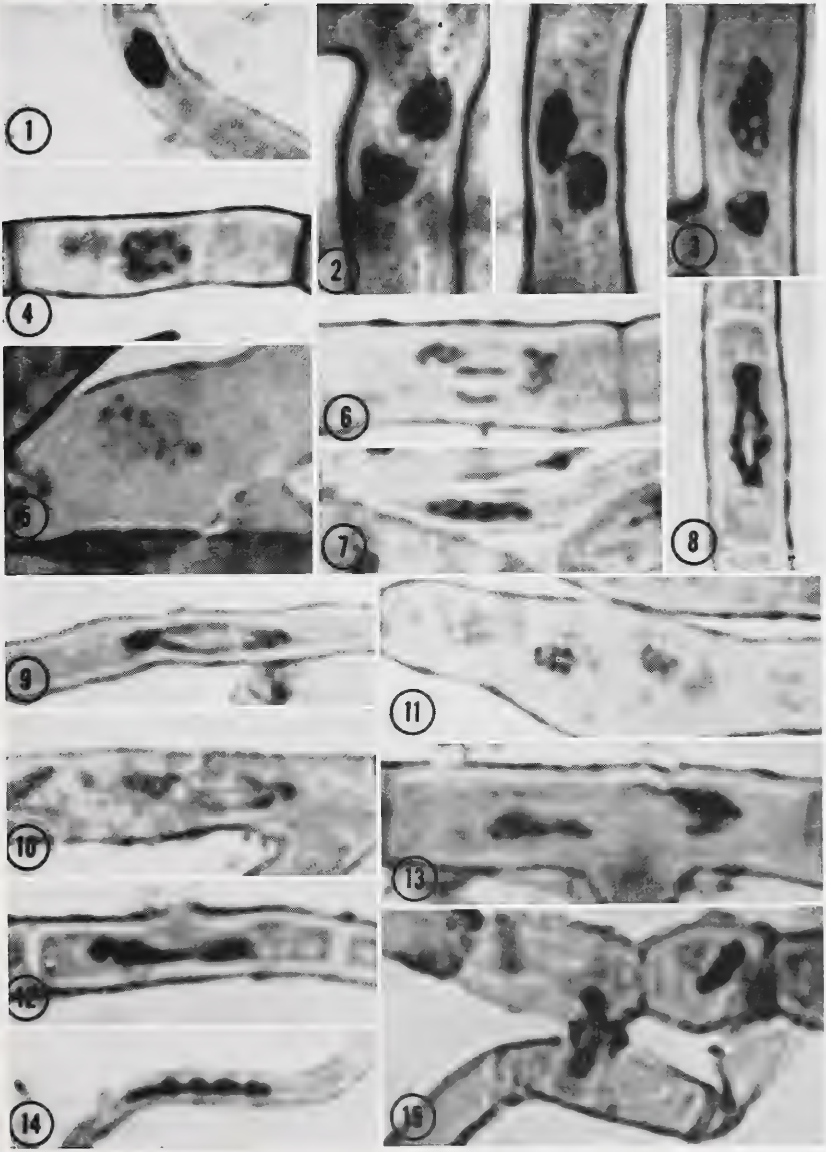
In the following descriptions of the nuclei, the nomenclature for the nuclear status of cells will be according to Jinks & Simchen (1966).

Results

Interphase

Vegetative mycelium with the nuclei in interphase was seen to be predominantly monokaryotic (Fig. 1). The nuclei were large, ellipsoid, usually centrally placed in the cells and showing little or no structural differentiation. These nuclei stained very well. Not infrequently, however, dikaryotic mycelial cells could be found interspersed between the monokaryotic cells (Fig. 2). These nuclei were similar in size, shape, degree of visible differentiation and staining intensity to the nuclei illustrated in Fig. 1. The dikaryotic condition was often associated with branched or anastomosed cells. Frequently, however, two nuclei could be found in cells where reasons for their presence were not immediately apparent.

Plate 1.—All figures are at a magnification of 3500x.
Fig. 1. Monokaryotic mycelium with nucleus in interphase.
Fig. 2. Dikaryotic mycelium with nuclei in interphase.
Fig. 3. Very early prophase nucleus showing structural differentiation.
Fig. 4. Prophase nucleus showing condensation of chromosomal material and nucleolus.
Fig. 5. Prophase nucleus showing weakly staining chromosomes.
Fig. 6. Metaphase chromosomes.
Fig. 7. Early anaphase.
Fig. 8. Anaphase with chromosomal material arranged on the outside of the spindle.
Fig. 9. Anaphase at further stage than Fig. 8.
Fig. 10. Late anaphase showing six chromosomes in left-hand nucleus.
Fig. 11. Early telophase showing six chromosomes in left-hand nucleus.
Fig. 12. Condensed late telophase nuclei.
Fig. 13. Post-division interphase nuclei.
Fig. 14. Beaded nucleus in narrow mycelium.
Fig. 15. Nucleus migrating between hyphae.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Prophase

At very early prophase the nucleus became structurally differentiated (Fig. 3), and a network of bands began to appear. The nucleus was, apparently, still surrounded by the nuclear membrane at this stage. Occasionally the nucleolus could be distinguished. At later prophase, nuclei showed a marked condensation of chromosomal material (Fig. 4). The nuclear membrane appeared to be still intact at this stage. Towards the end of prophase the chromosomes were still not highly condensed and could be seen as thin, rather weakly staining strands (Fig. 5). The nucleolus was often no longer visible and the nuclear membrane had apparently disappeared.

Metaphase

At metaphase discrete chromosomes could be seen (Fif. 6). The chromosomes were much contracted compared with prophase and stained fairly intensely. A count at this stage gave a tentative haploid chromosome number of six.

Anaphase

At anaphase the chromosomes were highly condensed and considerably smaller than at metaphase. In Fig. 7 the chromosome clumps have just begun to move apart on a structure which is regarded as a spindle. Continued movement of the chromosomes on the spindle (Fig. 8) produced a rhomboidal shape with the most densely staining material arranged around the outside of the spindle. Movement of the chromosomes continued until there was marked aggregation towards the poles with the spindle showing a large clear central area (Fig. 9). Remnants of the spindle could still be seen at late anaphase (Fig. 10). Movement of the chromosomes towards the poles appeared to be unsynchronised as at the left-hand pole the chromosomes were grouped fairly closely together and could be counted, whereas the chromosomes towards the right-hand pole were still moving. A count at the left-hand pole again gave a chromosome number of six.

Telophase

At early telophase the spindle was no longer visible (Fig. 11). The chromosomes were closely grouped but still distinct. Nucleoli were not seen. A count of the chromosomes in the left-hand daughter nucleus once more gave a total of six.

At late telophase (Fig. 12) the nuclei were highly condensed, small and often of irregular shape. No structural differentiation could be observed.

Post-division interphase

Daughter nuclei going into interphase (Fig. 13) enlarged, became somewhat diffuse, while irregular in shape, and stained as intensely as interphase nuclei before division.

General

In addition to the wide mycelium in Figures 1 and 2, a narrow mycelium was also observed, mainly at the surface of the culture medium. This narrow mycelium (Fig. 14) was also monokaryotic but the nuclei were much elongated and sometimes attentuated. Not much structural differentiation could be observed but the nuclei appeared moniliform. This shape of the nucleus is regarded as being due to the small hyphal diameter.

Although migration of nuclei from one cell to another along a hypha was not observed, migration of nuclei through anastomosing hyphae, which were frequently formed, was seen (Fig. 15). It is, therefore, highly likely that migration of nuclei along individual hyphae can occur as well.

Occasionally filamentous nuclei were observed. These showed varying numbers of granular thickenings and were very similar to the thread-like nuclei described by Dowding (1966).

Discussion

The staining time was considerably longer than that recommended by Ward & Ciurysek (1962) but was found to be the minimum time acceptable. After being stained for three hours mycelial nuclei were barely visible and the material was left to stain overnight. The fact that individual chromosomes could be distinguished at several stages is adequate proof that the staining time was not too long.

It is interesting to note the close similarity between the chromosome number of *Alternaria tenuis* (5) reported by Hartmann (1964) and the chromosome number (6) reported here for *Stemphylium botryosum*. In the absence of more detailed chromosomal data, however, no further inferences as to the relationship between these genera can be drawn.

The regularity of the divisions appeared to be high, which led to a low incidence of aneuploidy. This means that the stability of a specific genome will be high, subject of course to heterokaryotic selection.

Although occasional structures similar to the filament described by Dowding (1966) were seen they were not considered to be of any great importance, mainly because of their scarcity. In the face of an overwhelming number of figures suggestive of true mitosis, the "filaments" were considered as artifacts or transient chromosomal arrangements.

Ward & Ciurysek (1962) formulated the criteria for mitosis, i.e. demonstrable chromosomes, their alignment on a metaphase plate and the separation of chromatids to daughter nuclei. It is considered that, in the investigation reported here, these requirements were met, viz. chromosomes were demonstrated at several stages of division, the alignment on a metaphase plate was perhaps not shown but was at least suggested and movement of chromatids on a spindle was seen. It is, therefore, believed that the somatic divisions in *Stemphylium botryosum* can be accepted to be strictly mitotic.

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Bothalia 10, 2 : 335-339

Conidial Nucleation in Stemphylium botryosum

by

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Abstract

Conidial nucleation in an isolate of *Stemphylium botryosum* obtained from lucerne was investigated using the HCI-Giemsa technique. Conidiophores arose as anucleate buds into which somatic nuclei migrated. After attaining varying stages of complexity the terminal cell, which was strictly monokaryotic, developed into a conidium. Division of the young conidial nucleus and subsequent cell wall formation resulted in a multicellular conidium. Conidial cells contained either one, two or four nuclei. As all the conidial nuclei are derived from the single nucleus of the terminal conidiophore cell, the whole conidium is homokaryotic. There is thus no mechanism for the perpetuation of heterokaryons through the conidia.

Introduction

Stemphylium botryosum is a common fungus of worldwide distribution which is found on a wide variety of host plants. This study was undertaken to investigate the transmission of genotypes through the conidia.

Two closely similar genera, *Helminthosporium* spp. and *Alternaria tenuis* (Hughes, 1953) were investigated by different workers. Hrushovetz (1956) showed that, in *Helminthosporium sativum*, heterokaryosis could be perpetuated through the conidia, as several possibly dissimilar nuclei entered the developing conidium and continued to divide within it. Knox-Davies & Dickson (1960) showed that the same mechanism operated in *H. turcicum*. Although the same mechanism for the perpetuation of heterokaryons did exist in *Alternaria tenuis* (Hartmann, 1966), it was, however, also possible for only one nucleus to migrate into the young conidium. All the nuclei within a conidium would, therefore, be identical and the conidium would be homokaryotic.

Van Warmelo (1970) showed that nuclear migration between hyphae of *Stemphylium botryosum* could occur. There is thus a mechanism for the production and cytoplasmic maintenance of heterokaryons.

Materials and Methods

The strain of *Stemphylium botryosum* used in this study was isolated from lucerne and is the same isolate as was used in a previous investigation on somatic divisions (van Warmelo, 1970). Cultivation of the fungus and staining of the nuclei was done in the manner described before. The use of agar pieces cut from a culture instead of air-dried mycelium (Ward & Ciurysek, 1962) or Cellophane

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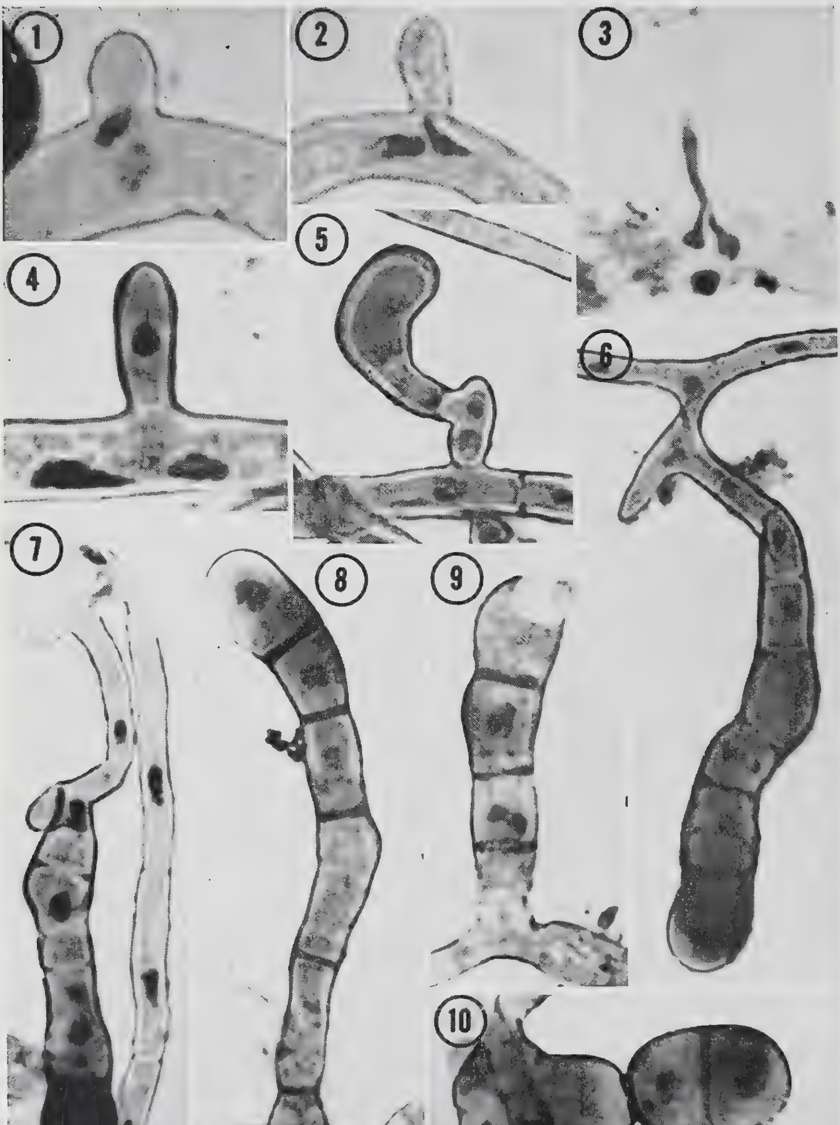
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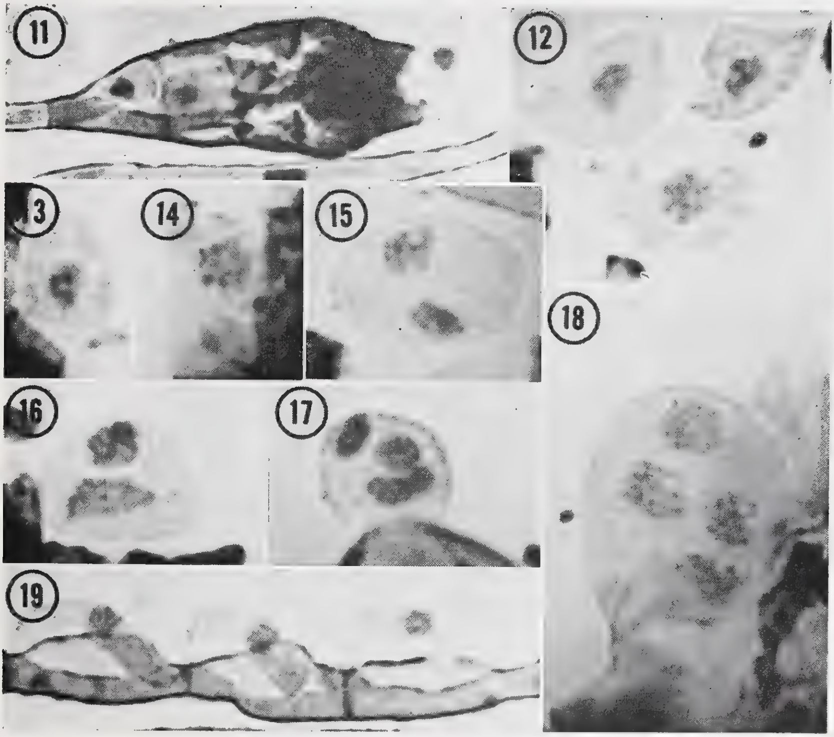

Plates 1 and 2.

Fig. 1. Anucleate bud arising from dikaryotic hyphal cell (3000x).
Fig. 2. Single nucleus migrating into a bud (3000x).
Fig. 3. Two nuclei migrating into a bud (3000x).
Fig. 4. Bud with central nucleus (3000x).
Fig. 5. Pigmented secondary branch arising from primary branch (2000x).
Fig. 6. Multicellular pigmented secondary conidiophore with terminal conidial primordium (2000x).
Fig. 7. Multicellular pigmented tertiary conidiophore (2000x).
Fig. 8. Primary branch developing into a pigmented conidiophore (2000x).
Fig. 9. Conidiophore with terminal nucleus in prophase (2000x).
Fig. 10. Bicellular developing conidium (2000x).
Fig. 11. Young multicellular conidium (2000x).
Fig. 12. Uninucleate conidial protoplasts (2000x).
Fig. 13. Conidial protoplast with nucleus in early prophase (2000x).
Fig. 14. Late prophase or metaphase nucleus (2000x).
Fig. 15. Dikaryotic conidial protoplast (2000x).
Fig. 16. Dikaryotic protoplast with nuclei in prophase (2000x).
Fig. 17. Quadrinucleate conidial protoplast (2000x).
Fig. 18. Conidial protoplast with four nuclei in interphase (2000x).
Fig. 19. Squashed conidiophore showing protoplasts with stained nuclei (2000x).

films (Roane, 1952) was found to be more convenient as sporulating areas could be identified on the surface of the agar and selectively removed for examination after staining.

In the following descriptions the nomenclature for the nuclear status of cells is according to Jinks & Simchen (1966).

Results

Branch formation

Hyphal branches originated from relatively unpigmented hyphae as anucleate lateral buds from individual cells which usually contained two nuclei (Fig. 1). With continued elongation of the bud, one or occasionally both nuclei migrated into the developing hypha (Fig. 2, 3, 4). A basal septum then formed to cut off the newly formed mono- or dikaryotic cell from its parental cell.

Subsequent development could give rise to either a new hypha or to a conidiophore.

Development of the conidiophore

Conidiophores were found to develop in a variety of ways. The primary branch described above could develop into a pigmented conidiophore of which the terminal cell became the conidium (Fig. 8).

The primary branch could, however, give rise to a secondary branch which could then develop into a pigmented conidiophore with an apical developing conidium (Fig. 5, 6).

Instead of developing into a conidiophore a secondary branch could form a tertiary branch which would become pigmented and develop into a conidiophore, as described above (Fig. 7).

At a certain stage, for which no definite stimulus was identified, the single nucleus in the terminal cell of the conidiophore, the young conidium, began to divide. It can be seen that cells of the conidiophore became dikaryotic, while the young conidium, with its nucleus in prophase (Fig. 9), remained monokaryotic. After division of the young conidial nucleus a septum was formed which separated the two daughter nuclei (Fig. 10). This process of nuclear division and septum formation was repeated until a multicellular monokaryotic homokaryotic conidium was formed (Fig. 11, 12). As development of the conidium progressed further nuclear divisions took place which were not followed by septum formation. (Fig. 13, 14). These divisions gave rise to dikaryotic cells (Fig. 15). A further division could follow to give rise to quadrinucleate cells (Fig. 16, 17, 18). No higher nuclear number per cell was seen during the investigation.

Not all the cells of a single conidium contained four nuclei at maturity and the conidium was thus a mono-, di-, multikaryotic homokaryon.

The heavily pigmented walls of the conidiophores and conidia made observation of the nuclei extremely difficult. It was found, however, that on squashing, the cell walls ruptured and released the intact protoplasts with the clearly visible stained nuclei (Fig. 16, 19).

Discussion

From the results it is evident that the mature conidium of *Stemphylium botryosum* contains several cells, each with a variable number of nuclei. All these nuclei are, however, genetically identical as they are all derived from the one nucleus present in the terminal cell of the conidiophore. The mechanism of nucleation resembles that of *Alternaria tenuis* (Hartmann, 1966) except that only one nucleus was present in the young conidium. Heterokaryosis cannot, therefore, be perpetuated through single conidia.

It is not known whether these differences in nucleation are of any taxonomic or phylogenetic importance.

The reason for the variable number of nuclei in the conidial cells must also remain unexplained. Multinucleate cells in both sexual and asexual spores have been reported in a number of different fungi (Carr & Olive, 1958; Hall, 1963; Knox-Davies, 1966; van Warmelo, 1966; Rogers, 1967).

Nuclear migration between hyphae of *Stemphylium* has already been demonstrated (van Warmelo, 1970). It is, therefore, probable that the mycelium is heterokaryotic. Each conidium, with the exception of the rare parasexual diploid or aneuploid nucleus, would contain haploid nuclei of one genotype. This would also explain the observed reduction in sporulation vigour if the genotype favouring sporulation differs from the genotype favouring growth in culture. Continued culture would thus be, in effect, an unconscious selection for the "culture genotype."

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Bothalia 10, 2 : 341-345

Some Members of the Sphaeropsidales from South Africa

by

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Abstract

Seventeen isolates of Sphaeropsidaceous fungi from South Africa are described. Of these, nine are described as new species: *Phyllosticta* **cussoniae,** *P.* **vangueriae,** *Ascochyta* **grewiae,** *Septoria* **combretiana,** *S.* **eucleae,** *S.* **lanneae,** *S.* **setariae,** *S.* **transvaaliana** and *S.* **tripteridis.**

Recently I received several specimens of Sphaeropsidales (Phyllostictales) from the National Herbarium (PRE) (Mycological Herbarium), Pretoria, for determination and revision. Some important works in this field are those by Kalchbrenner & Cooke (1880), Van der Byl (1922), Verwoerd & Du Plessis (1931), Nel (1942) and Doidge (1950).

Several of the species received were found to be unknown and are here described as new.

Phyllosticta cussoniae *Cejp,* sp. nov.

Maculae orbiculares, 0.5-1 cm in diam., amphigenae, cum rubro limbo, albescentes, praesertim in siccitate, paucae. *Pycnidia* dispersa, primum submersa, 80 — 90 μ in diam. *Conidia* maiore parte breviter ellipsoidea, aut globosa aut irregulariter ellipsoidea, cum numerus oleosis guttulis minoribus, cum 2 — 3 maioribusque, in utraque parte rotundata aequali, recta, aut ad unam partem inflexa, 4.2-5.6 x 7-12.5 (14) μ, infirme claro viridia.

Spots rounded, 0.5-1 cm. in diam., amphigenous, with red border, whitish, especially when dry, sparse on the leaves. *Pycnidia* scattered, at first immersed, black, 80-90 μ in diam. *Conidia* mostly short and ellipsoidal, with numerous smaller guttulae, and with 2-3 larger ones, regularly rounded at both ends, straight or curved at one side, 4.2-5.6 x 7-12.5 (14) μ, weakly pale green.

PRE 32821 (Holotype): On leaves of *Cussonia umbellifera* Sond., Schagen, Nelspruit district, Transvaal, 25. XII. 1933, leg. *L. C. C. Liebenberg* 3063; isotype in herb. Dr. K. Cejp, Praha.

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Phyllosticta vangueriae *Cejp*, sp. nov.

Maculae irregulares aut fere rotundatae, amphigenae, usque 1 cm in diam., clare cremaceo-flavescentes, in extremitate magis obscurae. *Pycnidia* obscuro-brunnea in ostiolo magis fusca, 15-20 μ in diam., punctiformia, copiosa, 80-90 μ in diam. *Conidia* breviter cylindriformia, recta, raro inflecta, cum 1 — 2 oleosis guttuli raro eguttulata, in utraque parte rotundata, 2.5-3 x 7-8 μ, claro viridia.

Spots irregular or almost rounded, amphigenous, up to 1 cm in diam., light pale yellow, the periphery being darker. *Pycnidia* brown, darker at the ostiole which is 15-20 μ in diameter, punctiform, numerous, 80-90 μ in diam. *Conidia* short cylindrical, straight, seldom curved, with 1-2 guttulae, seldom without, rounded at both ends, 2.5-3 x 7-8 μ, pale green.

PRE 32874 (Holotype): On the leaves of *Vangueria infausta* Burch., Schagen, Nelspruit district, Transvaal, July 1936, leg. *L. C. C. Liebenberg* 3544; isotype in herb. Dr. K. Cejp, Praha. PRE 26044: Near falls at Nelspruit, Transvaal, leg. *L. C. C. Liebenberg*, 1931, (with *Septoria* sp., conidia 2.5 x 44.5 — 60 μ).

Phyllosticta crastophila *Saccardo*, Michelia 1 : 153 (1889); Sylloge Fung. 3 : 61 (1884).

Spots indistinct, mainly oblong, about 2 x 3 mm in diam., rarely confluent and irregular, dirty ochraceous, the edge having a broad darker border. *Pycnidia* restricted into small mounds, rounded, lentiform, erumpent, black or almost black. *Conidia* oblong-cylindrical, straight, rounded at both ends, with 1 or 2 guttules and several dispersed guttulae, 3.5-4(5) x 5.5-8 μ, very pale green.

PRE 32080: On the leaves of *Setaria* sp., from Rietondale Grass Station, Pretoria, Transvaal, March 1940, leg. *L. C. C. Liebenberg* 3639.

Phyllosticta richardiae *Halstet*, New Jersey Agric. Exp. Sta. 1893.

Large spots scattered all over the upper surface of the leaves, 2-4 cm in diam., dark brown, irregular. Margin narrow having a dark brown border. *Pycnidia* numerous on the upper surface of the spots, being densely packed in some areas, leaving bare patches in other areas, globose, lentiform, epiphilous, dark brown, (80)90-130(140) μ in diam. *Conidia* elongate-cylindrical, rounded at both ends, one end attenuated, with (1)2 large guttulae, also with minute guttulae, 2.5-3(3.5) x 5.5-7(8.5) μ, pale green.

PRE 41655. On the leaves of *Zantedeschia* sp., locality not stated, 1956, leg. *V. A. Wager*. *Septoria callae* (Lasch) Saccardo (Sylloge Fung. 3 : 569, 1884, nomen, Bull. Soc. Mycol. de France 5:122, 1889, and Sylloge Fung. 10:382, 1892), is described on this host genus, but is distinguished by the small spots on the leaves, and especially by having somewhat curved stick-shaped conidia. It is known in Europe in parc Riga (Estonia, SSSR — Aksel, 1956).

Ascochyta grewiae *Cejp*, sp. nov.

Maculae in foliis copiosa, clara ferrugineae, fere subrubrae, plerumque rotundatae, raro confluentes et irregulares, saepissime 0.5 cm in diam., acute textura incolumni divisae. *Pycnidia* pauca, brunnea, punctiformia, 80-90 μ in diam. *Conidia cum* duobus cellulis, plerumque inferior cellula parva, raro unicellularia, cum 2 oleosis guttulis et aliquot minoribus guttulis, saepe inflectis ellipsoideis, in parte superiori cum extremitate rotundata (2)2.8-3.5 x (5.6) 8.4-11.2 μ, infirme claro viridia.

Spots abundant, light ferruginous, almost sub-reddish, regularly rounded, rarely confluent and irregular, often 0.5 cm in diam., sharply divided from the healthy texture of the leaf, sometimes covering a greater area of the upper surface of the leaves. *Pycnidia* few, dark brown, punctiform, 80-90 μ in diam. *Conidia* two-celled, the lower cell being usually smaller, seldom unicellular, with 2 guttulae and several smaller ones, often curved, ellipsoidal, with rounded tips, (2)2.8-3.5 x (5.6)8.4-11.2 μ, very pale green.

PRE 25967 (Holotype): On the leaves of *Grewia monticola* Sond., Nelspruit, Transvaal, 28. VIII. 1931, leg. *L. C. C. Liebenberg* 2773; isotype in herb. Dr. K. Cejp, Praha.

Ascochyta chenopodii *Rostrup,* Botan. Tidskrift 26:311 (1905).

Diplodina chenopodii Karsten, Hedwigia 24 : 73 (1885).

Ascochyta atriplicis (Vestergr.) Diedicke, Ann. Mycol. 2 : 180 (1904).

Spots round or irregular, 1 cm in diam., light ochraceous, whitish in the centre with a broad dark border. *Pycnidia* on the upper surface of the spots, sometimes also on the lower surface, globose, umbrous, becoming black, 120-150 μ in diam. *Conidia* sub-cylindrical, straight or sometimes curved, rounded at both ends, often irregular, with 2-3 large guttulae, also many minute ones, constricted, and narrowed, 2-4 x 14-22.5 μ, pale brown to yellowish green.

PRE 43127: On leaves of *Chenopodium murale* L., in Addo National Park, Alexandria district, C.P., July, 1962, leg. *L. C. C. Liebenberg* 6251.

Septoria combretiana *Cejp,* sp. nov.

Maculae amphigenae, rotundatae, 0.3-0.5 cm in diam., clare brunneae ferrugineaeque, saepe in medio magis obscurae. *Pycnidia* fusce ferruginea, in textura macularum submersa, paulum ad summum emergentia, 70-90 μ in diam. *Conidia* bacillaeformia, magis aut infirme adunca, cum 3-5 septa, saepe cum magnis 3-5 oleosis guttulis, 3-3.5(4) x 25-65 μ, infirme clare viridia.

Spots amphigenous, round, 0.3-0.5 cm in diam., light ferruginous brown, the centre often darker. *Pycnidia* dark ferruginous, round, immersed, scattered, few over the surface, erumpent, 70-90 μ in diam. *Conidia* bacillar, curved, or only slightly curved with 3-5 septa, often 3-5 large guttulae, 3-3.5(4) x 25-65 μ, of a very pale green colour.

PRE 33266 (Holotype): On the leaves of *Combretum erythrophyllum* (Burch.) Sond. (=*Combretum glomeruliflorum* var. *riparium* Sond.), Pelindaba, Pretoria district, Transvaal, 30.V.1944, leg. *E. M. Doidge & A. M. Bottomley;* isotype in herb. Dr. K. Cejp, Praha.

Septoria eucleae *Cejp,* sp. nov.

Maculae minutae, vix 2 mm in diam., irregulares, raro subrotundatae, subnigrescentes, aut obscuro-brunneae, perspicuae supra parte, densae. *Pycnidia* nigra, punctiformia, parva, 70-80 μ in diam. *Conidia* bacillaeformia, saepe torquentia aut inflectentia, cum numerosis septis, saepissime cum 4-5, sine oleosis guttulis, (2.5) 3-3.5 x (31)40-50(60) μ, pallide viridia.

Spots minute, scarcely 2 mm in diam., irregular, seldom sub-circular, almost black, or dark brown, distinct only on the upper surface, dense. *Pycnidia* black, punctiform, small, 70-80 μ in diam. *Conidia* bacillar, frequently curved or slightly curved, with many septa, or with just 4-5 septa, no guttulae present, (2.5)3-3.5 x (31)40-50(60) μ, pale green.

PRE 32812 (Holotype). On the leaves of *Euclea crispa* (Thunb.) Guerke var. *crispa* (=*Euclea lanceolata* E. Mey. ex A.D.C.), Waterkloof Ridge, Pretoria, Transvaal, 22.X.1928, collector unknown; isotype in herb. Dr. K. Cejp, Praha. This species is easy to recognise by the spots.

Septoria lanneae *Cejp*, sp. nov.

Maculae fere rotundatae aut paulum irregulares, e textura folii erumpentes cca O.5 cm in diam., amphigenae, obscure brunneae, sine limbo, acute dividae a textura salva aut cum lato obscuriore limbo. *Pycnidia* nigra, globosa, parva, 70 μ in diam. *Conidia* bacillaeformia, aliqua dissimilia crassa, recta, aut saepe distorta, cum 3-4 septis et densis magnis oleosis guttulis, 3-4.5 x 30-33.5 μ, claro infirme viridia.

Spots almost round or very slightly irregular, about 0.5 cm in diam. dark brown, amphigenous, without a border, distinct from the healthy texture of the leaf, or if separate, with a wide dark border. *Pycnidia* black, round and small, 70 μ in diam. *Conidia* bacillar, some unequally thick, straight or often twisted, with 3-4 septa and large dense guttulae, 3-4.5 x 30-33.5 μ, very pale green in colour.

PRE 32815 (Holotype): On the leaves of *Lannea edulis* (Sond.) Engl. (=*Odina edulis* Sond.), Suidwalliskraal, Lydenburg district, Transvaal, 8.I.1935, leg. *L. C. C. Liebenberg* 3367; isotype in Herb. Dr. K. Cejp, Praha.

Septoria setariae *Cejp*, sp. nov.

Maculae parviorae, longae, 1-2 mm in diam., ambiguo brunneae, obscuro brunneo limbo praetextae, dein medio albescente. *Pycnidia* pauca, rotundata, lentiformia, nigra, 80-90 μ in diam. *Conidia* bacillaeformia, recta aut subinflecta, quondam usque adunca, cum 3-5 indistinctis septis, sine oleosis guttulis, 2.5-3 x (28)60-80 μ, leviter viridia.

Spots smaller, 1-2 mm in diam., brownish, surrounded by a darker border, becoming whitish in colour in the centre. *Pycnidia* few in number, round, lentiform, black 80-90 μ in diam. *Conidia* bacillar, straight or moderately curved, with 3-5 indistinct septa, without guttulae, 2.5-3 x (28) 60-80 μ, pale green.

PRE 25866 (Holotype): On the leaves of *Setaria chevalieri* Stapf ex Stapf & C. E. Hubb, Soutpansberg, N. Transvaal, 12.I.1931, leg. *P. Watson;* isotype Dr. K. Cejp, Praha.

Septoria transvaaliana *Cejp*, sp. nov.

Maculae copiosae in foliis, nigro-brunneae, cum angusto fere nigro limbo, amphigenae, fere rotundatae aut irregulares, cca 2-3 mm in diam. *Pycnidia* parva, 70-80 μ in diam., nigra pauca. *Conidia* extende cylindriformia, nonnulla clava, raro directa, saepissime detorta, cum 2-3 septis atque aliquot oleosis guttulis, (2)3-3.5 x (24)39-70 μ, claro viridia.

Spots numerous on the leaves, dark brown, with a narrow black margin, almost round or irregular, about 2-3 mm in diam. *Pycnidia* small, 70-80 μ in diam., black, few in number. *Conidia* elongated cylindriform, often club-shaped, seldom straight, more frequently twisted, with 2-3 septa and several guttulae, (2)3-3.5 x (24)39-70 μ, pale green.

PRE 32895 (Holotype): On the leaves of *Hypoestes verticillaris* R.Br., Wolwekloof, Garstfontein, Pretoria, Transvaal, 22.II.1929, leg. *A. M. Bottomley;* isotype in herb. Dr. K. Cejp, Praha.

Septoria tripteridis *Cejp,* sp. nov.

Maculae irregulares, plerumque in margine folii, minus in medio, dein moderate oblongatae, 0.5-0.8 mm in diam., amphigenae, brunneo-canae, siccicate albescentes, in margine macularum cum lato brunneo-purpureo limbo praetexae. *Pycnidia* nigra, densae, copiosae, in superiore parte folii, punctiformia, 80-90 μ in diam. *Conidia* oblonga cylindriformia, fere claviformia, directa, saepius moderate detortae, cum 3-6 oleosis guttulis et sine septis, dissimiliter crassa, 2.5-3(3.5) x 55-70 μ, claro infirme vriridia.

Spots irregular, usually on the edges of the leaves rather than in the middle, moderately oblong, 0.5-0.8 mm in diam., amphigenous, brownish-grey in colour, becoming whitish when dry, broad brownish-purple border. *Pycnidia* black, copious, dense on the upper surface of the leaves, punctiform, 80-90 μ in diam. *Conidia* oblong cylindriform, straight, often moderately twisted, with 3-6 guttulae, without septa, unequally thickened 2.5-3(3.5) x 55-70 μ, of a very pale green colour.

PRE 41849 (Holotype): On the leaves of *Tripteris* sp. (Asteraceae), Fauresmith Municipal commonage, Orange Free State, April 1939, leg. *L. C. C. Liebenberg;* isotype in Herb. Dr. K. Cejp, Praha.

Septoria anaxea *Saccardo,* Michelia 1 : 189 (1879); Sylloge Fung. 3:549 (1884).

Spots irregular, copious on the leaves, regularly on the upper surface, at first ochraceous, becoming ferruginous-brown, with yellowish border, 1-2 cm in diam. *Pycnidia* punctiform or lentiform, 70-100 μ in diam., with large ostiole. *Conidia* bacillar, straight or slightly curved, rounded at both ends, with numerous guttulae, with 3-5 indistinct septa, 2-2.5(3) x 28-75 μ, very pale olive green.

PRE 32878: On the leaves of *Senecio isatideus* DC., Baviaanspoort, Pretoria district, Transvaal, 13.III.1935, leg. *L. C. C. Liebenberg* 3436.

Septoria callistephi *Gloyer,* Phytopathology 11:50-51 (1921).

Spots amphigenous, rounded becoming irregular, brown, with a broad reddish-brown border, 3-5 mm in diam., copious, especially on the lower leaves. *Pycnidia* blackish-ferruginous, copious, occasionally dense, punctiform or lentiform, 120-140 μ in diam. *Conidia* thread-shaped, somewhat thicker, straight or moderately curved, with 2-3 indistinct septa, 2-2.5(3) x 11-17 μ, pale green.

PRE 41664: On the leaves of Chinese daisies, *Callistephus chinensis* Nees, Pinetown, Natal, Dec. 1956, leg. *V. A. Wager,* 100.

Septoria gerberae *Sydow,* Ann. Mycol. 10:43 (1912).

Spots regular, circular, 3-6 mm in diam., or irregular and confluent, amphigenous, dark brown, with a darker brown border. *Pycnidia* brownish, often scattered, occasionally in small groups. *Conidia* bacillar, sometimes slightly curved, straight, with 2-3 indistinct septa, 2-2.5(3) x 14-22.5 μ, very pale green in colour.

PRE 32656: On the leaves of *Gerbera jamesonii* H. Bol. ex Hook f., Botanical Research Institute Garden, Pretoria, Transvaal, 5.XII.1939, leg. *A. M. Bottomley.* This species is distributed throughout South Africa: it is also known from Europe where the host is cultivated (Cejp & Jechová, 1967; Cejp & Deighton, 1969).

This species differs from *Phyllosticta gerbericola* (Ch.) Batista, which is found in Brazil, India and Czechoslovakia (Cejp, 1965, 1966).

Septoria rhamni-cathartica *Ces.* var. *rhamni-saxatilis Saccardo*, Mycotheca Veneta, No. 546; Sylloge Fung. 3:482 (1884).

Spots amphigenous, ferruginous-brown, without border, fading when dry, round, small, 0.5 cm in diam., sometimes smaller, abundant on the leaves. *Pycnidia* on the upper surface of the leaves only, punctiform, 80-90 μ in diam. *Conidia* bacillar, cylindrical, elongated, straight or strongly curved, club-shaped, septa not usually present, but when present from 3-5, frequently with large guttulae, 2.5-3(3.5) x 30-70 μ, light green to hyaline.

PRE 41640: On the leaves of *Phyllogeiton zeyheri* (Sond.) Suesseng. (=*Rhamnus zeyheri* Sond.), roadside, near Bulge River, Waterberg district, Transvaal, 22.VI.1955, leg. *L. C. C. Liebenberg*.

Septoria rhoina *Berk. & Curtis*, North American Fungi, No. 434.

Spots amphigenous, round, 2-3 mm in diam., dense on the leaves, whitish with black borders, especially when dry, brownish on the lower surfaces of the leaves. *Pycnidia* 4-5 in the centre of the spots, black, punctiform, with a broad ostiole, 80-100 μ in diam. *Conidia* elongated, vermiform, straight or twisted, some broader than others, some only thread-like, either without septa, or with 4-5 septa, 2.8-4(5.5) x 50-85 μ, very pale green to hyaline.

PRE 32728: On the leaves of *Rhus* sp., Schagen, Nelspruit district, Transvaal, June 1939, leg. *L. C. C. Liebenberg* 3575.

Phyllosticta rhoina Kalchr. & Cooke is found on *Rhus viminalis* Vahl, but differs from *Septoria rhoina* in the size of the conidia.

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Bothalia 10, 2 : 347-349

A New Species of Gonatobotryum from South Africa

by

K. T. van Warmelo*

ABSTRACT

An isolate of *Gonatobotryum* from barley kernels is described as a new species, *Gonatobotryum sclerotigenum*.

Early in 1969 a fungus was isolated from partially sterilized barley kernels received from Stellenbosch. The isolate proved to be an unknown species of *Gonatobotryum* Sacc. and is here described as new. Type specimens in the form of dried-down cultures on agar have been deposited in the National Herbarium (PRE) (Mycological Herbarium), Department of Agricultural Technical Services, P.O. Box 994, Pretoria, South Africa.

This appears to be the first record of this genus in South Africa.

Gonatobotryum sclerotigenum van Warmelo, sp. nov.

Fig. 1, 2, 3, 4, 5.

Hyphae fuscae, erectae, ramosae, septatae. *Conidiophora* ex substrato aut hyphis vegetatis enata, ramosa, septata, 10μ in diametro, spicula hyalina. *Conidia* in greges aliquando conferta, acatenulata, septata aut perraro uniseptata, ellipsoidea vel ovata, brevi pedicellata, pallide olivaceo-brunnea, 11 — 19 x 6 — 8μ. *Sclerotia* praesentia, pervariabilia, fere globosa, nigra.

Specimen examined: Van Warmelo, PRE 44252, (Holotype), on *Hordeum* spp. kernels, from Stellenbosch, Cape, May 1969. Cultures have also been deposited in the Centraalbureau voor Schimmelcultures, Baarn, Netherlands.

Colonies on corn-meal agar at 25°C covering the plate in approximately five days, loosely textured and woolly, at first hyaline but eventually darkening to light olivaceous brown, aerial mycelium abundant, reverse pale red. *Mycelium* hyaline at first, darkening eventually but remaining hyaline in parts, branched, septate, 10μ in diameter. *Conidiophores* arising from the substrate or from aerial vegetative hyphae, branched, becoming olivaceous brown, septate, 10μ in diameter, giving rise to hyaline spicules on which the conidia are borne. *Conidia* borne in clusters at intervals along the conidiophores, non-catenate, aseptate or only very rarely uniseptate, ellipsoid to ovate, briefly pedicellate, light olivaceous brown, 11 — 19 x 6 — 8μ. *Sclerotia* variable in shape and size, usually globose, black, irregularly distributed through the colony, up to 2 mm in diameter.

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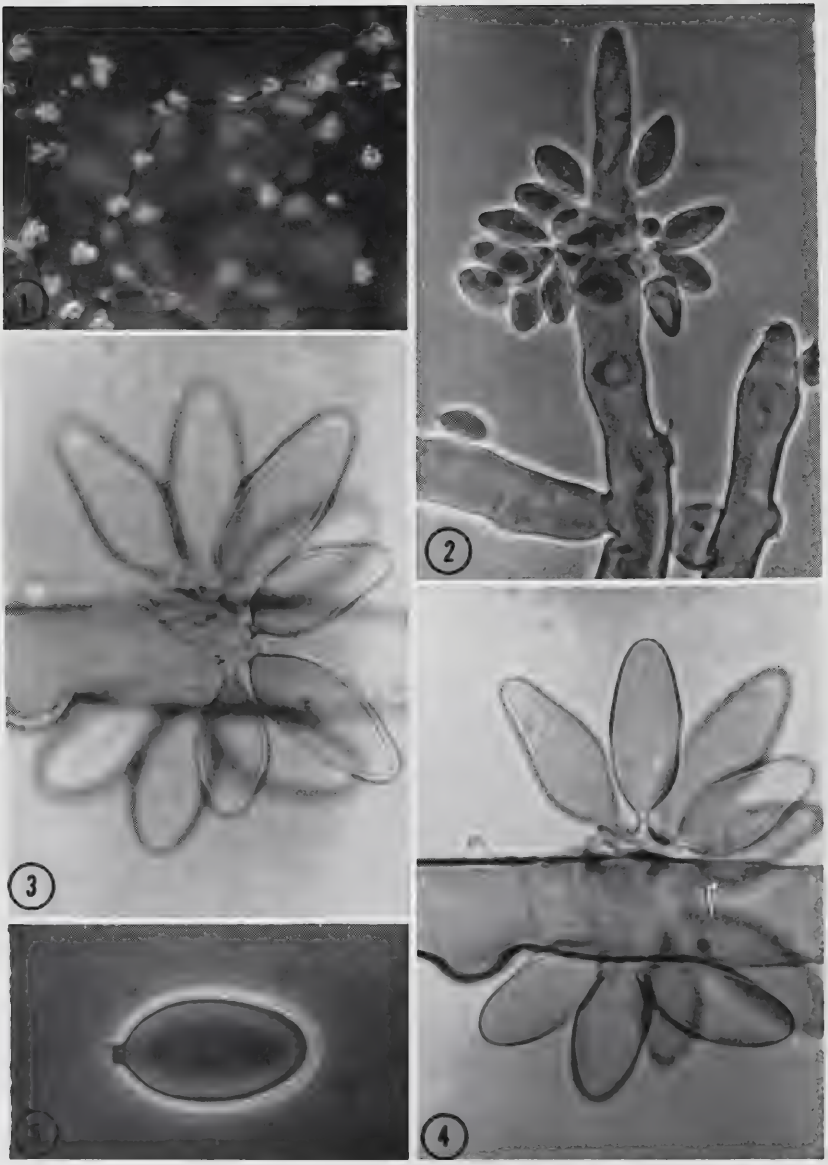

Fig 1. Conidiophores with spore clusters (46x).
Fig 2. Branched conidiophore showing spore cluster and growing tip (750x).
Fig 3 and 4. Sporogenous spicule showing conidia borne at different heights on the same spicule (1500x).
Fig 5. Mature conidium (2000x).

This species was compared with the other species of *Gonatobotryum* and was found to differ from them as detailed below. The conidia of *G. fuscum* Sacc. (Syll. Fung. 4 : 278, 1886), *G. maculicolum* (Wint.) Sacc. (Saccardo. Syll. Fung. 4 : 278, 1886), *G. bahiense* Batista (Ann. Soc. Biol. Pernambuco 13 : 154, 1955) and *G. indicum* Munjal & Gill (Ind. Phytopath. 16 : 62, 1963) are all considerably smaller than in *G. sclerotigenum*. The conidia of *G. dichotomum* Cooke & Mass. (Saccardo. Syll. Fung. 10 : 579, 1892) are not very different from those of *G. sclerotigenum* which, however, differs from *G. dichotomum* in having non-dichotomously branched conidiophores. The conidia of *G. apiculatum* (Peck) Hughes (Can. J. Bot. 31 : 594, 1953) are similar in size to those of *G. sclerotigenum* but differ by being borne in chains.

An additional important difference is the absence of sclerotia in all the previously described species of *Gonatobotryum*.

The sporogenous spicules are extremely delicate structures which degenerate and disappear after producing a variable number of conidia in different planes, leaving only a raised pad-like structure on the surface of the conidiophore, around which the spores remain clustered. The spicules can only be seen on developing portions of the conidiophore, and then only with some difficulty.

The placing of this species in the genus *Gonatobotryum* justifies some comment. The genus *Gonatobotryum* Sacc. (Saccardo. Syll. Fung. 4: 278, 1886) was described as being a dark or pigmented *Gonatobotrys* Corda (Saccardo. Syll. Fung. 4: 169, 1886). These two genera are morphologically similar and can thus be separated only on the basis of colour. Barron (Mycologia 56: 313 — 316, 1964) discussed the value of colour as a distinguishing criterion between the genera *Stachybotrys* Corda and *Hyalostachybotrys* Srinivasan, and concluded that the presence of colour as the sole difference between these two genera is unacceptable.

On the basis of the pigmented conidia and conidiophores this new fungus is correctly placed in *Gonatobotryum* Sacc. It is, however, felt that, following the same reasoning as Barron (loc. cit.), the genus *Gonatobotryum* Sacc. should be reduced to synonymy with *Gonatobotrys* Corda. As no authentic material of either genus was examined, however, this change is not made here.

Acknowledgement

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Bothalia 10, 2 : 351-354

The Acacia Species with Glandular Glutinous Pods in Southern Africa

by

J. H. Ross

Abstract

The complex of *Acacia* species with glandular glutinous pods, consisting of seven species, is endemic to southern Africa. A map showing the distribution of these species is given. A new key to the identification of these species is provided and characters that enable members of the complex to be distinguished from *A. karroo* Hayne are discussed.

The South African species of *Acacia* with glandular glutinous pods were dealt with by Verdoorn in Bothalia 6 : 153-160 (1951). Recently Brenan in Kew Bull. 21 : 480 (1968) has described yet another species with glandular pods from Mozambique. As there is now an additional species within the complex and, as more material and information has become available since Verdoorn's treatment, it seems worthwhile to re-examine the entire complex in southern Africa.

The complex now consists of seven species, namely, with species enumerated chronologically: *A. nebrownii* Burtt Davy, *A. borleae* Burtt Davy, *A. permixta* Burtt Davy, *A. swazica* Burtt Davy, *A. exuvialis* Verdoorn, *A. tenuispina* Verdoorn and *A. torrei* Brenan. The complex is endemic to southern Africa. The distribution of each species may be seen in Fig. 1.

Fig. 1 reveals that no species within this complex occurs in the Orange Free State, in Lesotho or in the Cape. The Transvaal has the greatest number of species; of the seven within the complex only *A. torrei* is absent. *A. exuvialis* and *A. permixta* are endemic to the Transvaal, *A. exuvialis* occurring in the eastern portion and *A. permixta* in the western. *A. torrei* is endemic to the Manica e Sofala region of Mozambique. *A. borleae* occurs in southern Mozambique, the eastern Transvaal, eastern Swaziland and northern Zululand. *A. swazica* occurs in the south-eastern Transvaal, in Swaziland and just south of Abercorn Drift in northern Zululand. *A. tenuispina* is found in eastern Botswana and in the western and central Transvaal, whilst *A. nebrownii* ranges from South West Africa to Botswana and the northern Transvaal.

This complex of species is taxonomically difficult. The species are all very closely related to one another and to *A. karroo* Hayne and appear to have been derived from *A. karroo* 'stock' during earlier times. It is not clear whether each species was independently derived from the ancestral stock or whether some of the species have given rise to others. Each species seems to have different habitat preferences, the different species being possibly the outcome of differing environmental conditions acting upon a common or similar gene pool. Some specimens cannot be referred either to *A. karroo* or to *A. tenuispina* with

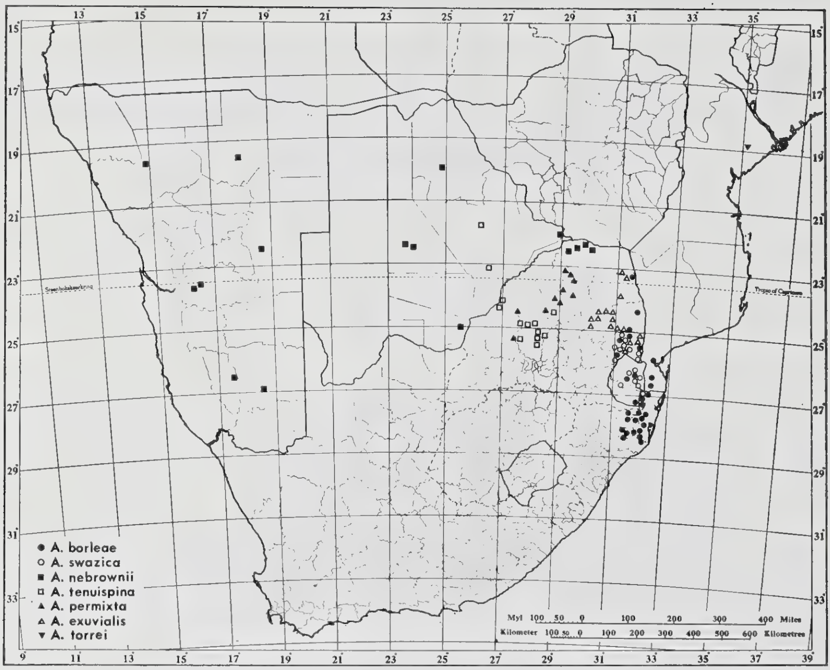

Fig. 1.— The known distribution of the Acacia species with glandular glutinous pods in Southern Africa.

certainty. For example, *Codd 7047* (PRE) from north of Pienaars River (Grid Reference: 2528 AB Pretoria) was described by the collector as "possibly a hybrid between *A. karroo* and *A. tenuispina.*" Some plants from the Springbok Flats agree vegetatively with *A. tenuispina,* but lack glandular pods and are therefore hesitantly referred to *A. karroo.* The two species may well hybridize but this requires careful field studies.

Apart from certain specimens referred to above as being possible intermediates between *A. karroo* and *A. tenuispina,* each of the species can usually be distinguished from *A. karroo* fairly easily. The species differ from *A. karroo* in that they are usually small, slender plants and are smaller in all of their parts. With the exception of *A. borleae* and *A. torrei* the remaining species have typically fewer pinna and fewer leaflet pairs than *A. karroo.* The young branchlets, leaf petioles, rachides and rachillae are slender and not robust as in *A. karroo.* Unlike *A. karroo,* the flowers are not aggregrated into such dense terminal panicles, but tend often to occur in axillary fascicles along the young stems. In addition, the pods are smaller, of a different shape and texture. The species perhaps most likely to be confused with *A. karroo* are *A. swazica* and *A. exuvialis.* However, the bark in both species is different being pale greyish to chestnut or reddish-brown and often peeling off in strips in contrast to the dark brownish-black or reddish-brown rough bark of *A. karroo.*

A new key to the identification of the species within this complex has been drawn up which makes provision for *A. torrei.* In contrast to the key given by Verdoorn (l.c.), where the first dichotomy was based on pod shape and whether the glands on the pods are conspicuous or not, the emphasis in this key is initially on vegetative characters. This is because pod shape in some of the species is more variable than initially recognized and also because it enables some of the species to be identified when in the flowering or even in the vegetative state. However, even in the presence of pods, it is felt that the vegetative characters used in the key enable certain species to be identified far more readily than by relying on pod characters. All species usually have flowers and pods in various stages of maturity contemporaneously. It may be argued that in the absence of pods it is not possible to establish whether the plant in question is a member of the complex with glandular glutinous pods. Whilst this may occasionally be true, it is usually possible and, certainly with a little practice, relatively simple to establish whether or not a plant belongs to this complex.

Young branchlets densely tomentose with spreading white hairs ...... *A. permixta*

Young branchlets glabrous, subglabrous, or occasionally very sparingly pubescent:

- Mature leaves with 7-20 pinna pairs:
  - Leaflets glandular-punctate with distinct glands on the lower surface and on margins giving the margin a crenate appearance; pods glabrous or subglabrous, glands inconspicuous ...... *A. borleae*
  - Leaflets not glandular-punctate on lower surface and on margins; pods distinctly, although sparingly, pubescent especially on the raised portions over the seeds, glands conspicuous ...... *A. torrei*
- Mature leaves with up to 6 pinna pairs:
  - Involucel at or near the base of the peduncle; usually only 1 pinna pair, rarely 3 ...... *A. nebrownii*
  - Involucel at or above the middle of the peduncle:
    - Stoloniferous shrubs; leaflets small, up to 4.3 mm long, 1.5 mm wide; pods straight or almost so, 4.5—8.0 mm wide ...... *A. tenuispina*
    - Non-stoloniferous shrubs; leaflets larger, up to 10 mm long, 5.1 mm wide; pods distinctly torulose or only slightly falcate, occasionally straightish; usually broader than above:
      - Spines slender; midrib and veins usually very conspicuous abaxially; pods slightly to distinctly falcate, occasionally ± straight, 0.7—1.2 cm wide, glands conspicuous; seed circular or subcircular ...... *A. swazica*
      - Spines frequently enlarged and swollen basally; midrib and veins inconspicuous abaxially; pods torulose, 4.5—9.0 mm wide, glands not conspicuous; seed elliptic ...... *A. exuvialis*

A. permixta clearly differs from the remainder of the complex in having young branchlets that are usually clothed with a dense indumentum of spreading white hairs, a feature that enables the species to be distinguished even in the vegetative state. *A borleae* and *A. torrei* differ from the remaining species in having mature leaves with at least seven pinna pairs. *A. borleae* differs from *A. torrei* in having leaflets that are glandular-punctate on the lower surface and on the margins which gives an irregularly crenate appearance. However, the margins of leaflets of *A. torrei* that have been subjected to the ravages of certain insects and sometimes appear crenate must not be confused with leaflets of *A. borleae*. The pods of *A. borleae* are usually glabrous and the glands inconspicuous, whereas in *A. torrei* the pods are distinctly, although sparingly, pubescent especially on the raised portions over the seeds, and the glands are conspicuous. In addition, a large geographical discontinuity separates the two species. *A. permixta, A borleae* and *A. torrei* can therefore be distinguished from the remainder of the complex and from one another on the basis of vegetative characters alone.

The position of the involucel on the peduncle is the important character in differentiating *A. nebrownii* from the remaining species. The stoloniferous habit, slender spines and small leaflets distinguish *A. tenuispina* from *A. swazica* and *A. exuvialis.* In *A. exuvialis* the thin bark peels off, but this feature has also been noted on some specimens of *A. swazica.* The spines of A. *swazica* are slender, whereas in *A. exuvialis* they are often somewhat enlarged and the members of each pair united basally. The conspicuous midrib and veins on the lower surface of the leaflets provide a useful means of identification in dried specimens of *A. swazica,* but it must be mentioned that the midrib and veins are not so conspicuous in living plants. They apparently only become conspicuous when the tissues have dried out. Pod shape also enables the two species to be differentiated.

Bothalia 10, 2 : 355-358

Two New Ornithogalum Species from South West Africa

by

A. A. Obermeyer

Ornithogalum candidum *Oberm.*, sp. nov., *O. rautanenii* Schinz affinis, sed plantae robustiores, foliis latioribus, perianthio majore staminum filamentis ex appendiculatis differt.

Bulbus angustus in collo longo productus. *Folia* 2 (raro 3) linearia ad late linearia ad basin vaginata, apice acuminata, 6-15 cm longa, 6-12 mm lata patentia glauca glabra striata margine saepe undulata. *Racemus* simplex ad 20-florus; scapus validus teres; bracteae minorae membranaceae; pedicelli filiformes patentes. *Perianthium* candidum circa 2 cm diam., segmentis anguste oblongis. *Staminum filamenta* anguste lanceolato-subulata. *Ovarium* ovoideum sessile, ovulus in quoque locula 8. *Capsula* late obovoidea chartacea; semina applanata oblanceolata nigra.

South West Africa. — 2317 Rehoboth: Büllspoiter Fläche, *Giess 388* (PRE, holo.; M; WIND); Form Vrede, REH 433, *Giess 9110*. 2417 Mariental: between Mariental and Aris, *Werdermann & Oberdieck 2268;* farm Witvley near Mariental, *Giess 3878;* Swartrand, ± 30 miles W. of Mariental, *Basson 146*. 2115 Karibib: farm Nudis (Altenbrunn), *Seydel 245*.

Bulb narrowly ovoid, 2-4 cm in diam., produced into a neck 8-10 cm long, outer covering papery, rough, greyish- or light brown. *Leaves 2,* rarely 3, linear to broadly linear, up to 15 cm long and 1.2 (-2) cm broad, clasping below, spreading, apex acuminate often laxly curled upwards, the margins usually wavy and involute, glaucous, glabrous, striate. *Raceme* simple, up to 15 cm high and up to 20-flowered; scape terete, firm, bracts small, ovate-acuminate, clasping, membranous; pedicels filiform, 1-3 cm long, patent, becoming firm in fruit. *Flowers* with a white shiny star-shaped perianth about 2 cm in diam., segments broadly linear, 1 cm long and 4 mm broad, apex obtuse, with a broad 5-nerved midrib. *Stamens* somewhat shorter than the perianth-segments; filaments linear, anthers versatile, introrse. *Ovary* narrowly ovoid, sessile, with about 8 ovules per locule, style terete, stigma apical, papillate. *Capsule* broadly obovoid, 3-angled, about 1 cm long, chartaceous; seeds flattened, oblanceolate in outline, about 6 mm long, tapering to the funiculus, with a blackish-brown shiny loose skin (uncertain if seeds were mature).

Apparently confined to the Rehoboth-Mariental region although there is one record from Karibib. Found in open stands and covering extensive areas. According to collectors the flowers appear in their thousands after the first rains and cover the ground with a white, shiny carpet and on the ridges the flower masses resemble snowdrifts. Mr. W. Giess, who collected the species in

PLATE 1. — **Ornithogalum candidum,** Farm Vrede, Rehoboth, South West Africa (*Giess* 9110). (Photos by W. Giess).

several localities, noted that they preferred coarse quartzite gravel with underlying limestone but were absent from pure limestone or in red sand. They were eaten by animals which is surprising since species of *Ornithogalum* are known to be very poisonous.

var. **tubiforme** *Oberm.*, var. nov. Perianthii segmentis ad basin connati.

South West Africa. — 2317 (Rehoboth): farm Buellsport, *Strey 2624* (PRE. holo.).

The fusion of the bases of the perianth-segments to form a short tube about 3 mm long is very unusual for this genus. The stamens are fused to the tube at the base but exserted above it. The leaves are narrow and folded, c.2 mm wide.

Ornithogalum recurvum *Oberm.*, sp. nov., *O. rautanenii* Schinz affinis, sed plantis majoribus, foliis latioribus, racemis elongatis, perianthii segmentis recurvis differt.

Planta ad 55 cm alta. *Bulbus* oblongo-globosus 10 cm longus, 5 cm diam., tunicis tenuibus brunneis transverse striatis. *Folia* c. 7 lineari-lanceolata ad 27 cm longa, 3 cm lata, ad basin vaginata apice attenuata, glabra glauca nitida. *Racemus* elongatus c. 35 cm longus; scapus teretus, bracteis minutis subulatis; pedicelli filiformes patentes ad 18 mm longi. *Perianthii segmenta* recurvata late linearia alba. *Staminum* filamenta in dimidio inferiore abrupte expansa in squamam latam, parte superiore erecta stylos cingentia. *Ovarium* disco basali leviter 6-lobato, infra in stipite brevi contractum. *Capsula* late triangularis; semina discoidea nigra.

South West Africa. — 1712 (Posto Velo): Kaokoveld, banks of the Kunene River at long. 1226, lat. 1715, among rocks in mountains, *Story 5848* (PRE, holo., bulb cultivated at PRE). 1812 (Sanitatas): flats near waterhole at Orupembe, gravelly calcareous soil, *De Winter & Leistner 5732* (fruiting).

Bulb oblong, 10 cm long and 5 cm in diam. covered by thin shiny brown transversely striate scales; neck absent. *Leaves* rosulate, erect, about 7, linear-lanceolate, up to 27 cm long and 3.5 cm broad, clasping at the base, apex attenuate, glabrous, dark glaucous green, shiny. *Raceme* overtopping leaf-rosette (in the cultivated type-specimen the scape is up to 30 cm long and straight) or about equal to the scape, which is bent outwards near the middle; with a few minute sterile subulate bracts above; fertile bracts similar. *Flowers* up to 40, on patent filiform pedicels up to 2 cm long, which become wiry in fruit. *Perianth* with the segments recurved, their tips touching the apex of the pedicel, broadly linear, 8 mm long and 1.5 mm broad, white with a broad green 3-5 nerved central band, apex obtuse cucullate, barbate. *Stamens* erect, filaments expanded in lower half to form a square base which folds inwards above around the ovary from where the filiform upper part then forms a connivent tube around the style; anthers versatile, introrse. *Ovary* expanded below in a shallowly 6-lobed disc from a shortly stipitate base, turbinate above, with about 18 biseriate ovules in each chamber; style filiform, about as long as the stamens, stigma apical, shortly 3-lobed, papillate, exserted when stamens shrivel. *Capsule* broadly triangular, c. 18 mm long and broad, depressed in the centre, walls thin, greenish; seeds discoid, 7 mm in diam., black, shiny.

The perianth, with its recurved segments, resembles a *Drimia* flower but in all other respects it conforms to *Ornithogalum*. The segments, after anthesis, return to the bud position closing over the ovary. In the type-plant the recurving was very characteristic, as can be seen in the photographs, but in the other

Plate 2. — **Ornithogalum recurvum,** Kaokoveld, South West Africa *(Story* 5848). (Whole plant at left, x $\frac{1}{4}$; inflorescence at right, x 1).

cited specimen, which was in the fruiting stage *(De Winter & Leistner 5732)*, this could not be observed as no flowers were present. A few staminal filaments, that had persisted below the capsule, showed the typical broadened bases and it matched the type in all other respects. The species is very near *O. stapfii* but the plant is larger, with the larger and broader leaves forming a distinct upright rosette, and the recurved perianth especially distinguishes it from that species.

Bothalia 10, 2 : 359-362

A Note on the Acacia giraffae x A. haematoxylon Hybrid

by

J. H. Ross

Abstract

Over twenty years ago the first specimens of a hybrid between *Acacia giraffae* Willd. and *A. haematoxylon* Willd. were collected in the Hay district of the Cape Province. From an examination of all available herbarium specimens the characteristics of *A. giraffae*, *A. haematoxylon*, and the hybrid are tabulated. Some of the characters displayed by the hybrid, for example number of pinna pairs, are found to be intermediate between the values recorded for the parent species, while other characters, for example the degree of pubescence and the presence of glands, tend to be inherited from one parent species only. It appears, therefore, that there is a marked tendency for certain characters associated together in a parent to be associated in the hybrid.

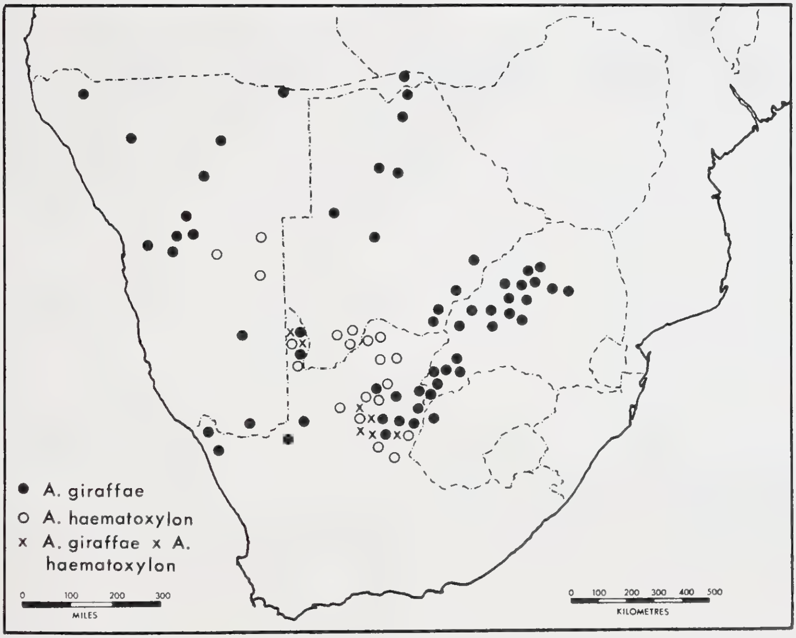

Fig. 1.—The known distribution of **Acacia giraffae, A. haematoxylon** and **A. giraffae × A. haematoxylon**, based on an examination of herbarium specimens.

Over twenty years ago the first specimens of a remarkable *Acacia* were collected in the Hay district of the Cape Province by Mr. J. P. H. Acocks (No. 12689) and Dr. L. E. Codd (No. 1261). The collectors noted that the plant exhibited characteristics of *A. giraffae* Willd. and of *A. haematoxylon* Willd. and concluded that it was in all probability a hybrid between the two species. A number of specimens have been collected subsequently from other localities in the Cape Province and these have all lent support to the idea that the plants are hybrids between *A. giraffae* and *A. haematoxylon*. Leistner in Mem. Bot. Surv. S.Afr. 38 : 67 (1967) noted: "In river areas where *Acacia giraffae* and *A. haematoxylon* form mixed stands, especially in the lower Auob and Nossob, a tree is occasionally encountered (Plate 24), which is regarded as a hybrid between the two species." Evidence suggests that although the hybrid plants are relatively widespread they are nowhere common. Usually only a solitary plant is found or at the most five or six individuals.

It is now proposed to examine the relevant characteristics of *A. giraffae*, of *A. haematoxylon*, and of the hybrid to determine the position that the last-named occupies in relation to the two species and, if possible, to attempt to establish some of the characters which each parent contributes. The information given in Table 1 has been compiled from an examination of all available herbarium specimens. Seventy-six specimens of *A. giraffae*, 35 of *A. haematoxylon*, and 15 of the hybrid were examined.

The hybrid has the spreading, rather weeping habit of *A. giraffae* and the bark resembles that of *A. giraffae*, while the foliage is greyish and resembles that of *A. haematoxylon*.

Leaflet size tends to be almost intermediate between that of *A. giraffae* and *A. haematoxylon*. The leaflets are not tightly compressed laterally as in *A. haematoxylon* and so do not appear as though simply pinnate. The hybrid plants are not uniform in regard to leaflet size as some have decidedly larger leaflets than others. There is, therefore, a small but readily apparent range in leaflet size within the hybrid complex. For example, *Acocks 12689* (PRE) is typical of the one extreme with large leaflets and *Leistner 1340* (KMG, PRE) is typical of the other extreme with smaller leaflets. *Leistner 1728* (KMG, PRE) is almost intermediate in size between the two extremes.

Leaflets in the hybrid are sparingly to densely puberulous as in *A. haematoxylon* which is in sharp contrast to the glabrous leaflets of *A. giraffae*. Likewise, in contrast to *A. giraffae*, the petiole, rachides and rachillae are densely puberulous and have numerous minute scattered reddish glands as in *A. haematoxylon*.

A. giraffae has (1-) 2-3 (-6) pinna pairs, *A. haematoxylon* (6-) 12-20 (-22) and the hybrid (3-) 7-11 (-12) pairs. Thus the number of pinna pairs in the hybrid is intermediate between the values recorded for the parent species. Similar results were obtained by Moffett in Heredity 20 : 621-629 (1965) who found that the number of pinna pairs in hybrids between *A. irrorata* Sieb. ex Spreng. and *A. mearnsii* De Wild. was "approximately midway between the parent species values, ..." This behaviour was also very similar to that found in hybrids between *A. decurrens* (Wendl.) Willd. and *A. mearnsii* by Moffett and Nixon in Heredity 12 : 199-212 (1958).

Inflorescences in the hybrid are grey in bud as in *A. haematoxylon* owing to the dense grey pubescence on the corolla lobes, whereas in *A. giraffae* the buds are yellow. As opposed to the glabrous, eglandular peduncle of *A. giraffae*,

TABLE 1. — Synopsis of differences between *A. giraffae* Willd., *A. haematoxylon* Willd., and *A. giraffae* x *A. haematoxylon*.

A. giraffae	*A. giraffae* × *A. haematoxylon*	*A. haematoxylon*
Stipular spines usually fused basally, often inflated into rounded "ant-galls" up to 2.5 cm in diameter, tapering apically.	Stipular spines ± straight, usually slightly stouter than in *A. haematoxylon*, not fused basally	Stipular spines ± straight, slender, not fused basally
Foliage dark green	Foliage greyish	Foliage greyish
Petiole 4-14 mm long, glabrous or subglabrous	Petiole 2—9 mm long, densely grey tomentose, with minute scattered glands	Petiole 1—5 mm long, densely grey tomentose, with minute scatttered glands
Rachis 0—5.5 (0.7-2.7) cm long, glabrous or subglabrous	Rachis 0.9—4.8 (2.0—4.4) cm long, densely grey tomentose, with minute, scattered glands	Rachis 0.8—5.1 (1.9—3.7) cm long, densely grey tomentose, with minute scattered glands
Pinnae 1—6 (2-3) pairs	Pinnae 3—12 (7—11) pairs	Pinnae 6—22 (12—20) pairs
Rachillae 1.3—4.2 (1.6-3.2) cm long, glabrous or subglabrous	Rachillae 0.4—2.2 (1.4—2.0) cm long, densely grey tomentose, with minute scattered glands	Rachillae 0.3—1.0 (0.5—0.8) cm long, densely grey tomentose, with minute scattered glands
Leaflets 7—18 (9-12) pairs, 4—11.5 (8.1 ± 2.0) mm long, 0.7—2.4 (1.5 ± 0.3) mm wide, linear to linear-oblanceolate, glabrous	Leaflets 11—25 (15—22) pairs, 1—4 mm long, 0.4—1.1 mm wide, linear to linear-oblong, often slightly falcate, sparingly to densely puberulous	Leaflets 12—24 (14 — 21) pairs, up to 0.8 mm long, 0.4 mm wide, very tightly compressed laterally, superficially appearing simply pinnate, oblong, densely puberulous
Penduncle 1.8—5.5 (3.1 ± 0.8) cm long, glabrous or subglabrous	Peduncle 1—3 cm long, densely grey puberulous	Penduncle 1.0—2.4 cm long, densely grey puberulous
Involucel apical	Involucel apical	Involucel apical
Calyx 1.5—2.8 mm long, apices of lobes glabrous or sometimes with few glandular hairs	Calyx 1.8—2.4 mm long, apices of lobes sparingly to densely pubescent	Calyx 1.4—1.9 mm long, apices of lobes sparingly to densely pubescent
Corolla 2.7—3.6 mm long, glabrous or apices of lobes with few glandular hairs	Corolla 2.2—3.0 mm long, apicces of lobes sparingly to densely pubescent	Corolla 1.8—2.6 mm long, apices of lobes sparingly to densely pubescent
Stamen filaments to 7.5 mm long, often connate into groups basally	Stamen filaments to 4 mm long, often connate into groups basally	Stamen filaments to 4.5 mm long, often connate into groups basally
Ovary sessile	Ovary sessile	Ovary sessile
Legume semi-lunate or suborbicular, sometimes curled into almost a complete circle, woody, not umbonate over the seeds, 6—13 cm long, 1.8—5.0 cm wide, 0.8—2.0 cm thick	Legume falcate or curled into a complete circle, margin irregular, often constricted between the seeds and ± moniliform, umbonate over the seeds, 7—14 cm long, 1.2—2.3 cm wide, up to 1 cm thick	Legume linear, falcate or curled into a complete circle, margin entire or irregularly constricted between the seeds and ± moniliform, umbonate over the seeds, 8—21 cm long, 0.6—1.4 cm wide, up to 0.9 cm thick
Seeds 10—14 mm x 8—10 mm	Seeds 9—12 mm x 6—8 mm	Seeds 8.5—11.5 mm x 6.5—9 mm
Areole 6—9 mm x 3.5 — 5.5 mm, ± closed	Areole 6—8 mm x 2.5 — 3.5 mm, ± closed	Areole 5—7 mm x 3.5—5 mm, ± closed

peduncles are sparingly to densely puberulous and glandular. The stamen filaments in *A. giraffae* and in *A. haematoxylon* are sometimes connate into groups basally, whereas in the hybrid the degree of fusion is sometimes greater than in either parent.

Pods of the hybrid are almost intermediate in width between those of *A. giraffae* and those of *A. haematoxylon.*

Although the parentage of the hybrid is known, it is not known which species functions as the male parent and which as the female. Furthermore, it is not known whether the same species is always, for example, the male parent or whether the same species may sometimes serve as the female parent. Consequently there is at present no understanding of differences arising in the progeny as a result of this. As the hybrid is fertile it should be possible to find all stages of back-crossing with the parents. Careful field studies are necessary to resolve these problems. A few plants grown from seed of a hybrid tree have been established on the National Botanic Garden, Pretoria.

Thus it may be seen that some of the characters displayed by the hybrid, for example number of pinna pairs and leaflet size, are intermediate between the values of *A. giraffae* and those of *A. haematoxylon,* while other characters, for example the degree of pubescence and the presence of glands, are those exhibited by a single parent, namely *A. haematoxylon.* The hybrids are usually as densely pubescent and as glandular as *A. haematoxylon* and are not only sparingly pubescent as an intermediate state between glabrous *A. giraffae* and densely pubescent *A. haematoxylon.* Recombination of the characters of the two parent species apparently does not take place at random, but there is a marked tendency for characters associated together in one species to remain associated in the hybrid. The multifactorial genes tend, therefore, to be linked together in the hybrid in the same way as they were in the parents, certain combinations perhaps being favoured by natural selection. As in the case of *A. haematoxylon* and the hybrid, the presence of glands and the degree of pubescence were also found (Ross in Webbia 22 : 203-223, 1967) to be correlated in *A. caffra* (Thunb.) Willd., the greater the degree of pubescence the more numerous the glands.

I am grateful to Dr. K. D. Gordon-Gray of the Bews Botanical Laboratories, University of Natal, for reading the manuscript and for advice.

Bothalia 10, 2 : 363-371

New and Interesting Records of African Plants

by

Various Authors

ASCLEPIADACEAE

A New Combination in Schizoglossum

Bullock, in Kew Bull. 1952 : 417 (1952), proposed the upholding of the generic status of *Stenostelma* to accommodate *S. capense* Schltr. (= *Schizoglossum aciculare* N.E.Br.) and the closely related species *Stenostelma corniculatum* (E. Mey.) Bullock.

Huber, in Prodr. Fl. S.W.Afr. 114 : 52 (1967), transferred *Stenostelma capense* Schltr. to *Schizoglossum capense* (Schltr.) Huber.

The latter classification appears preferable and it thus becomes necessary to transfer *Stenostelma corniculatum (Lagarinthus corniculatus* E. Mey.) also to *Schizoglossum* with synonymy as follows:

Schizoglossum corniculatum *(E. Mey.) R. A. Dyer*, comb. nov.

Lagarinthus corniculatus E. Mey., Comm. 208 (1837).

Gomphocarpus corniculatus (E. Mey.) Dietr., Syn. Pl. 2 : 901 (1840).

Krebsia corniculata (E. Mey.) Schltr. in Bot. Jahrb. 20, Beibl. 51 : 41 (1895); N.E.Br. in Fl. Cap. 4, 1 : 587 (1907). (*Krebsia* Harv. 1868, not of Eckl. & Zeyh., 1836).

Stenostelma corniculatum (E. Mey.) Bullock in Kew Bull. 1952 : 417 (1952).

R. A. Dyer.

Distinctions Between Duvalia and Huernia

In an article published earlier in this volume, pp. 45 - 54 (1969), L. C. Leach transferred *Duvalia tanganyikensis* Bruce & Bally, *D. procumbens* R. A. Dyer and *D. andreaeana* Rauh to the genus *Huernia*. In the absence of any published comment it could be construed that the changes met with general agreement. For my part this is not so.

It has been pointed out by various authors that distinctions between genera of the Stapelieae are often arbitrary. A close study makes it fairly clear that there is no sharp distinction between the two genera *Duvalia* and *Huernia* as at present constituted. On the other hand the respective type species *D. elegans*

(Masson) Haw. and *Huernia campanulata* (Masson) R.Br. leave no room for confusion. There is no call for the amalgamation of the two genera and the problem is to select the most natural line of distinction.

N. E. Brown in Fl. Cap. 4, 1 : 526 (1907) used the presence of teeth between the corolla-lobes as a distinctive character for *Huernia*. He went on to describe the outer corona as spreading upon and more or less adnate to the bottom of the corolla-tube and the inner corona as arising from the upper part of the staminal column, of 5 simple lobes incumbent upon the backs of the anthers and equalling or exceeding them, subulate or clavate or thickened at the apex, often with a slight transverse dorsal ridge at their base but *no crest, wing or dorsal horn*.

In the case of *Duvalia*, N. E. Brown described the corona as arising near the top of the staminal column and stipitate, and the inner corona-lobes as turgid, ovoid, more or less pointed at each end, subhorizontal, with the *dorsal point usually somewhat raised* and the inner closely incumbent on the backs of the anthers and sometimes longer than them but not produced into erect points.

Leach tabulates the four main characters on which he relies to distinguish the two genera, characters present in *Duvalia* and absent in *Huernia:* Corona stipitate; denticles (usually) at base of leaves; corolla (usually) replicate; corolla lobes (usually) ciliate. He lists known exceptions to the last three of these characters in *Duvalia,* and it still remains to be seen whether *Duvalia maculata* N. E. Brown var *imaculata* Luckhoff is an exception in not having the stipitate corona normally found in *Duvalia.*

Duvalia tanganyikensis, D. procumbens and *D. andreaeana* are excluded from *Duvalia* and placed by Leach in *Huernia,* because the coronas are not stipitate, the stem-teeth (rudimentary leaves) are devoid of denticles at the base and the corolla-lobes are neither replicate nor ciliate, although he allows other species without these characters to remain in *Duvalia.*

Leach omits, as not being diagnostic, (a) intermediate corolla-lobes, as occurring in both genera to some extent, although usually much more prominent in *Huernia;* (b) corona shape, since, as he says, the outline of the outer corona and the form of the inner lobes are closely matched in both genera.

It is in our interpretation of the importance of the structure of the inner corona-lobes that we differ most. Leach, p. 54, points out that there is considerable variation in the inner corona of *D. procumbens* and, in his words, the lobes may be either widely spreading with the inner face somewhat channelled, or strictly erect and more or less triangular in cross-section. What Leach is describing is not the inner face of the lobe but the upper face of its dorsal prolongation. His figure, p. 47, shows this very nicely. This dorsal prolongation is quite foreign to the genus *Huernia,* as stressed by N. E. Brown. Leach is in further error, therefore, in saying at the foot of p. 46 that his rearrangement requires no amendment to the existing generic circumscription of *Huernia.*

In an effort to tidy up the genus *Duvalia,* Leach has introduced exceptions into *Huernia* where none existed before. None of *Duvalia tanganyikensis, D. procumbens* or *D. andreaeana* has teeth between the corolla-lobes; in none is the inner coronal-lobe limited to the presence of a transverse dorsal ridge and all have a dorsal prolongation of the inner corona-lobe giving them the characteristic *Duvalia* appearance. Bruce, Bally and Rauh expressed no doubt in placing their species in *Duvalia* where, together with *D. procumbens,* they should remain.

Huernia verekeri Stent var. *pauciflora* Leach, the controversial species, does appear to show a tendency towards *Duvalia* but does not quite reach the borderline in the dorsal development of its inner corona-lobes and should remain in *Huernia* as concluded by Leach.

R. A. Dyer.

CELASTRACEAE

A New Name in Catha

Catha transvaalensis *Codd*, nom. nov.

Lydenburgia cassinoides Robson in Bol. Soc. Brot. 39 : 35 (1965).

Catha cassinoides (Robson) Codd in Bothalia 9 : 124 (1966), nom. illegit., non Webb & Berth.

I am grateful to Dr. G. Kunkel of Las Palmas Herbarium for drawing my attention to the prior use of the name *Catha cassinoides* by Webb & Bertholet.

L. E. Codd.

GRAMINEAE

A New Species of Aristida from South West Africa

Aristida dewinteri *Giess*, sp. nov., *A. stipoidi* Lam. affinis, sed gluma inferiore breviore apice rotundo tenuiter fimbriato, glumis superioribus et interioribus flavis apice macula nigra praedito differt.

Gramen annuum, ad 1 m altum. *Culmi* simplices, nodis 2-3, recti vel subgeniculati. *Panicula* diffusa. *Spiculae* pallidae, sed glumae apice macula nigra praeditae. *Glumae* valde inaequales, 1-nervatae, subcoriaceae; inferior 3.5-4.0 mm longa, late oblonga, apice obtuso rotundato fimbriato; superior 10-11 mm longa, lanceolata, apice plus minusve acuto membranaceo fimbriato vel sublacerato. *Lemma* 3-nervatum, cylindricum, coriaceum, in dimidio inferiore glabrum superne scabridum, 7-8 mm longum (callo incluso), inter apicem lemmatis et basin columnae articulatum; columna 1.3-1.4 mm longa, tortilis, scabrida; aristae 3, scabridae; centralis laterales excedens, c. 3.5 cm longa; laterales c. 2.5 cm longae; callus c. 1 mm longus, manifeste bifidus, dense retrorse setosus setis basin versus brevioribus. *Palea* 0.7 mm longa, subcoriacea, late oblonga, enervis hyalina, rotundata. *Lodiculae* magnae, 1-1.25 mm. longae, ovatae, tenuiter membranaceae, apice rotundato; nervi 7-9, distincti. *Stamina* 3; antherae cultratae, 3 mm longae, pallide luteae. *Caryopsis* linearis, 3-3.5 mm longa; hilum lineare caryopsidem aequans (embryo indistinctus ob caryopsides immaturas).

Type: South West Africa, Kaokoveld (Grid 1613, Uncocua), 18 miles west of Enyandi, *Giess* 9345 (PRE, holo.; K; M; WIND; US).

Annual forming erect tufts up to 1 m high. *Culms* simple, 2-3-noded, straight or somewhat geniculate, nodes and lower internodes usually purple, glabrous, very finely striate. *Leaf-sheath* shorter than the internodes, rather lax, often striate particularly upwards, with a flake of wool at the mouth. *Collar* smooth, usually purplish. *Ligule* a dense fringe of long woolly hair. *Panicle* effuse and open, pallid, up to 30 cm long and 15 cm wide. *Spikelets* pallid, glabrous, the glumes each with a black spot at the apex. *Glumes* very unequal, 1-nerved, firm and thick in texture; lower 3.5-4.0 mm long, broadly oblong, apex obtuse and rounded, fimbriate; upper 10-11 mm long, lanceolate, apex more or less acute, thin, membranous. *Lemma* 3-nerved, cylindrical, coriaceous, scabrid in the upper half,

otherwise glabrous, 7-8 mm long (callus included), articulated between the apex of the lemma and the base of the column; column up to 2.2 cm long, twisted, scabrid; awns 3, scabrid; central awn exceeding the others in length, about 3.5 cm long; lateral awns about 2.5 cm long; callus about 1 mm long, distinctly bifid, densely retrorsely bristly, the bristles diminishing in length towards the base. *Palea* 0.75 mm long, subcoriaceous, broadly oblong, nerveless, apex hyaline, rounded. *Lodicules* large, 1-1.25 mm long, ovate, thinly membranous, apex rounded; nerves 7-9 in number, distinct. *Stamens* 3; anthers cultrate, 3 mm long, pale yellow. *Caryopsis* linear tapering to an acute apex, 3-3.5 mm long. *Hilum* linear, as long as the grain. *Embryo* (indistinct due to immature grains).

This species has so far been found only along the Kunene River between the Epupa Falls and Enyandi in the Kaokoveld of north-western South West Africa. It often occurs in pure stands and is then conspicuous due to the bright yellow inflorescences. This species is named in honour of Dr Bernard de Winter for his contributions to the study of South West African plants.

W. Giess.

LILIACEAE

A New Aloe from South West Africa

Aloe erinacea *Hardy*, sp. nov. *A. melanacanthae* Berger affinis, sed foliis compactioribus brevioribus biconvexis, floribus brevioribus subventricosis non incurvatis differt.

Plantae solitariae vel glomeratae, acaules vel caulescentes, caulibus decumbentibus 60 cm longis. *Folio* griseo-viridia dense rosulata suberecta deinde patula vel recurvata deltoideo-lanceolata 8-16 cm longa 3-4 cm base lata, supra convexa vel ad basim plana, nonnunquam ad apicem spinis nigricantibus paucibus armata, subtus convexa ad apicem carinata, carinis 5-8 spinis armatis, margine spinis nigricantibus deltoides 5-9 mm longis 10 mm distantibus armata. *Inflorescentia* simplex semper solitaria arcuato-adscendens usque ad 1 mm longa. *Pedunculus* laete griseo-viridis vel ochraceus base complanatus circa 1.5 cm diam., circa 25 bracteis vacuis membranaceis leviter fuscis ovato-acuminatis 2.5-3 cm longis 1 cm latis 8-10 nervatis instructus. *Racemi* dense multiflori 24-26 cm longi 5-6 cm diam., gemmis congestis patulis deinde cernuis carmesinis apicibus schistaceis. *Bracteae* membranaceae fuscae 3-5 nervatae infimae 25-27 mm longae 4.5 mm latae pedicellis longiores. *Pedicelli* infimi 18-19 mm longi. *Perianthium* subcylindricum leviter ventricosum 28 mm longum ad medium 7 mm latum base rotundatum haud stipitatum; segmenta exteriora libera apicibus subacutis; segmenta interiora libera eburnea apicibus viridibus. *Antherae* 4 mm exsertae. *Ovarium* viridi-brunneum 5-6 mm longum 2-2.5 mm diam.; stigmata denum 7 mm exserta. *Capsula* non vidi.

Type: South West Africa, Lüderitz District, Witputz South, 21.9.1968, *Hardy* 2619 (PRE, holo.).

Plants succulent, solitary or in compact groups of five or more, sometimes with a decumbent stem up to 60 cm long. *Leaves* grey-green, densely rosulate, suberect becoming spreading or recurved, deltoid-lanceolate, 8-16 cm long, 3-4 cm broad at the base; upper surface convex to flat low down often with a few sharp, black spines near the apex, grey-green; lower surface convex with a distinct keel for one-third of its length, the keel armed with 5-8 deltoid, sharp, black teeth, otherwise same colour as the upper, margins armed with deltoid, horny, black teeth which are evenly spaced throughout, 5-9 mm long, 10 mm

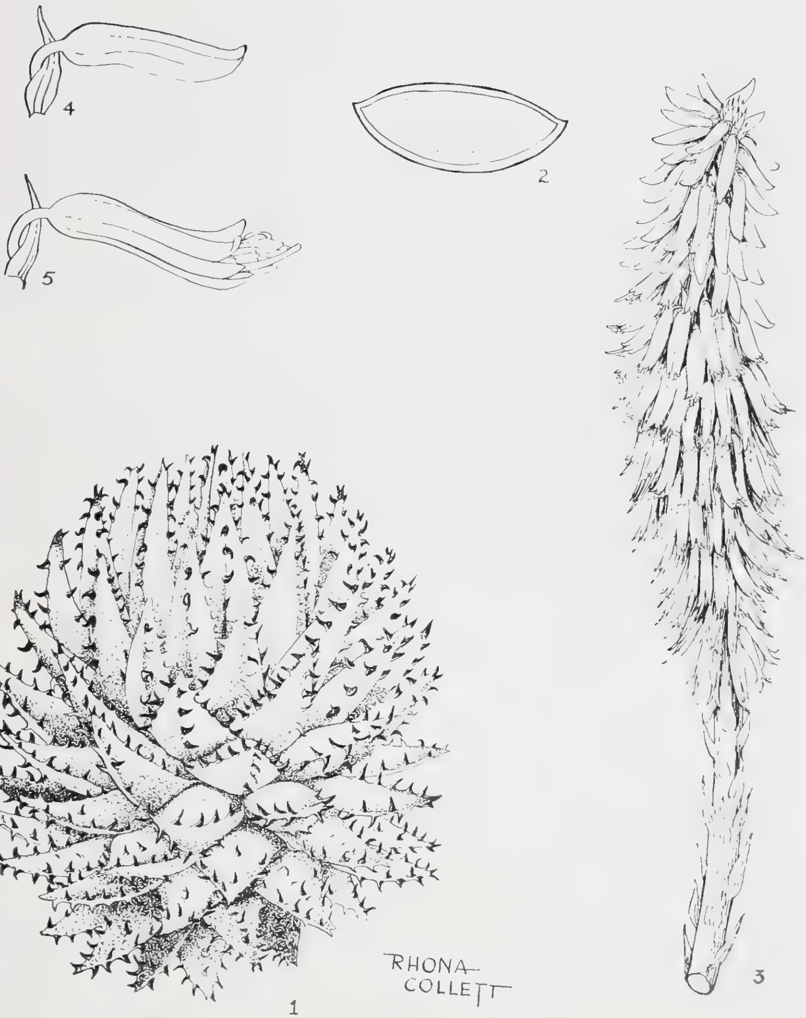

Fig. 1. — **Aloe erinacea.** 1, plant growing in the National Botanic Gardens, Pretoria, x $\frac{1}{2}$ (approx.); 2, cross section of leaf, x 1; 3, inflorescence from the natural habitat, x $\frac{1}{2}$; 4, bud, x 1; 5, flower, x 1.

apart. *Inflorescence* simple, usually one from a rosette, arcuate-ascending up to 1 m high. *Peduncle* pale grey-green to yellowish brown, flattened low down, about 1.5 cm diameter, clothed with about 25 sterile bracts which are 2.5-3 cm long, 1 cm broad at the middle, ovate-acuminate, membranous, brownish, 8-10 nerved. *Racemes* densely flowered, 24-26 cm long; buds crowded, horizontally spreading to spreading downwards, crimson with slate-grey tips. *Bracts* thin, membranous, brownish, 3-5 nerved, longer than the pedicel, the lowest 25-27 mm long, 4.5 mm broad at base. *Pedicels* about 18-19 mm long on the lower flowers. *Perianth* cylindric and slightly narrowed above the ovary, subventricose, about 28 mm long, 7 mm broad at the middle, rounded at the base, not stipitate; outer segments free to the base, apices subacute, with 4-5 nerves which meet near the apex, inner segments free, yellowish-white, greenish at apex. *Anthers* exserted by 4 mm. *Ovary* greenish-brown, 5-6 mm long, 2-2.5 mm diam.; stigma exserted by 7 mm. *Capsule* not seen.

This species is nearest *Aloe melanacantha* Berger from which it can be distinguished by the more compact rosette, the shorter leaves which are more biconvex and eventually more spreading and by the shorter, subventricose perianth which is not incurved.

Aloe erinacea was first collected at Witputz-Suid by Mr. Jan Botha of Rosh-Pinah, South West Africa, in 1967. In September 1968 he accompanied the author to this locality where a number of plants were collected, some of which were planted at Rosh-Pinah and the balance being cultivated at the National Botanical Gardens, Pretoria.

The accompanying description was based on plants which flowered at Rosh-Pinah in August 1969.

D. S. Hardy.

MYRSINACEAE

A Note on Myrsine in Southern Africa

When preparing the text for an illustration of *Myrsine africana* L. for publication in Flowering Plants of Africa, the second author noted that the species is dioecious. This fact is not recorded in the first author's treatment of the species in the Flora of Southern Africa 26 : 5-6 (1963), although it is mentioned in the generic description that flowers are often unisexual. One result of the oversight is that the key in the Flora is not entirely accurate. The first character given in the key to distinguish *Myrsine africana* from *M. pillansii* Adamson is "Anthers exserted beyond corolla-lobes" versus "Anthers included within corolla-lobes." In *M. africana* the anthers are exserted only in the male flowers; in the female they are included. As regards *M. pillansii*, the anthers referred to are of female flowers. In other words, the anthers of male flowers in *M. africana* are compared with those of female flowers in *M. pillansii*. The leaf characters, however, used in the key to distinguish the two species, hold good. So far, male flowers of *M. pillansii* do not appear to have been collected, so we are ignorant of their structure. The female flowers contain "male" organs resembling fertile stamens, but in all specimens examined by the authors none has shown pollen, consequently they are merely staminodes.

Adamson in his original description of *M. pillansii* in J. S. Afr. Bot. 7 : 204 (1941) refers to male flowers as follows: "*in floribus masculis ovarium abortivum minutum adest.*" However, in the type material which was kindly sent on loan

from the Bolus Herbarium, there is no trace of functionally male flowers. What Adamson probably observed were young female flowers with undeveloped ovaries and staminodes.

After Vol. 26 of the Flora of Southern Africa appeared, a specimen of *M. pillansii (Moss* sub TRV 19775) from Witpoortjie, Krugersdorp district, in the Transvaal, was located in the National Herbarium, Pretoria, and further specimens from the Transvaal have since been collected by Mr. J. H. Vahrmeijer (Nos. 1763 and 1819) of the Botanical Research Institute, at Breed's Nek in the Magaliesberg and by Mr. G. K. Theron (No. 1954) at Loskop Dam. It is clear that *M. pillansii* has a much wider distribution than was at first realized and it is all the more surprising that no functionally male flowers have yet been preserved. It would be appreciated, therefore, if collectors would search for male trees of *H. pillansii* to fill this serious gap in our knowledge of the species.

R. A. Dyer & D. J. B. Killick.

ZAMIACEAE

The Cones of Encephalartos inopinus

When *Encephalartos inopinus* R. A. Dyer was first described in Bothalia 8 : 169 (1964), only a few plants and two damaged young male cones had been recorded. No additional information came to light for inclusion in the account for the Flora of Southern Africa 1 : 13 (1966). In January 1969, however, both male and female cones became available for description: a beautiful full-sized, but immature, female cone collected by Mr. G. J. Alberts of the Nature Conservation Section of the Transvaal Administration, and male cones from wild and cultivated plants through the help of Mr. C. T. Phillips of Verwoerdburg

Mr. Alberts had undertaken extensive field excursions in the rough terrain of the Olifants River Valley in the Lydenburg district of the Transvaal to determine the distribution range of the species and to estimate if possible the degree to which unauthorized collecting had been taking place. He found the cycad population to be fairly widely scattered but nowhere was there a colony with young plants to prove that active regeneration is taking place from seed. Approximately 50 per cent of the plants recorded by him were on north-facing cliffs, krantzes or rocky outcrops and the other half on various other aspects including some in south-facing positions. The tallest perfectly upright stem measured approximately 1.5 m, whereas the longest stem, now procumbent, measured nearly three times this length (15 ft).

The male cone from the wild — one of a cluster — was subcylindric, more or less elliptic-oblong in outline, whereas three cones from a single stem on a garden plant, were more oblong-lanceolate. The scales of the cone from the wild were dense and the beak slightly decurved, by comparison with the relatively open, spreading scales of the plant in cultivation. It was found also that the garden cones must have had a considerably higher moisture content judging by the shrivelling and weight for size ratio. The following details amplify the original description.

Cones 1 to several in a head; the scale faces green and densely covered with small white papillae giving a general light green „matt" appearance. *Male cones* subcylindric, narrowed more or less equally to both ends or sometimes more gradually tapered towards the apex, 18-25 cm long, 6.5-8 cm diam.,

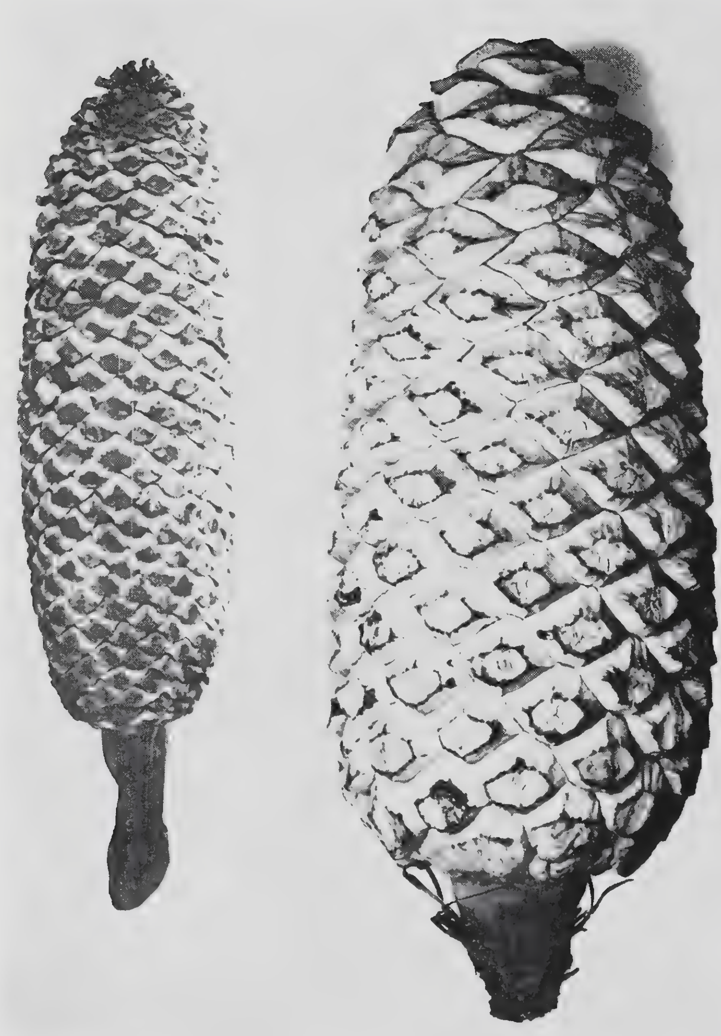

PLATE 1.—**Encephalartos inopinus** *R. A. Dyer;* left, male cone; right, female cone, both densely and minutely whitish papillate; female cone-scales largest toward the apex of the cone.

pedunculate; peduncle 6-8 cm long, 2.5-3 cm diam. at top, not much thinner at base; median scales spreading more or less horizontally from axis with deflexed beak, 2.5-3 cm long, 7-8 mm thick vertically, with sharp lateral angles, moderately ridged down upper surface, nearly flat on microsporangial surface, with pollen-sacs not spreading quite to margin; bulla-face minutely papillate, projected into a beak 9-10 mm long; upper facet with median receding ridge; lower facet continuous with microsporangial surface; terminal facet subquadrate 7-8 x 7-8 mm. *Female cones* broadly subcylindric, slightly narrowing to obtuse apex, 31 cm tall 15 cm in greatest width near base, and with stout peduncle; peduncle obconic, 5-6 cm long, 5 cm thick at top and narrowed to base, subtended by numerous linear-filiform tomentose bracts about the same length as the peduncle; median scales about 5 cm long, 4-4.75 cm broad, 3 cm thick vertically, with lateral ridges extending into incurved lateral lobes; bulla-face about 10 mm prominent, minutely and densely whitish papillate; upper facet with a slightly undulate surface and 1 or 2 receding ridges; lower facet similar to upper but more acutely angled from the terminal facet; terminal facet slightly below centre of bulla-face, slightly concave, about 2.5 cm broad, 1.5 cm wide vertically (slight cracking of surface at time of photograph and description probably due to slight drying out after period of 4-5 weeks since removal from parent plant); scales in the upper $\frac{1}{3}$ of the cone, broadest, up to 5 cm broad, with the terminal facet narrower vertically by comparison with those of the lower scales.

The leaf characters of this species are distinctive among the South African species of the genus and the minutely papillate nature of the cone-scales recorded above is one more obvious distinguishing feature.

R. A. Dyer.

Bothalia 10, 2 : 373-378

Notes on the Genus Brachystelma

by

R. A. Dyer

Abstract

The distribution and synonymy of *Brachystelma blepharanthera* H. Huber, *B. circinatum* E. Mey. and *B. dinteri* Schltr. are discussed in the light of material recently available. New names include a new combination: *B.* **stenophyllum** (Schltr.) R. A. Dyer (*Siphonostelma stenophyllum* Schltr.) and three new species: *B.* **cupulatum** R. A. Dyer from South West Africa, *B.* **tenue** R. A. Dyer and *B.* **vahrmeijeri** R. A. Dyer, both from Natal.

An effort has been made to clarify some long outstanding nomenclatural problems in southern Africa. For this purpose specimens collected by K. Dinter in South West Africa were kindly sent on loan to the National Herbarium from the S.A. Museum Herbarium by the Director of the National Botanic Gardens, Kirstenbosch. As an introduction to the conclusions arrived at, it seems appropriate to recall an observation by Dinter when describing his *Brachystelma grossarthii* in 1914; the variation in the length and width of the leaves of the species were so great that when dealing with extreme forms one might readily think that one was confronted by two completely distinct species. He went on to say that the same phenomenon of variability is met with in *Brachystelma dinteri* Schltr. and several other related plants growing on the Rehoboth sand flats in South West Africa.

Brachystelma arnotii *Baker* in Ref. Bot. 1 : t.9 (1869); N.E. Br. in Fl. Cap. 4, 1 : 845 (1908).

B. grossarthii Dinter, Neue Pfl. S.W. Afr. 16 (1914); H. Huber in Prodr. Fl. S.W. Afr. 114 : 12 (1967).

Dinter referred in his description of *B. grossarthii* to the similarity of *B. arnotii* Baker but gave no diagnostic characters to distinguish between them. He stated, however, that he was unable to find an inner corona in *B. grossarthii*. An examination of the syntypes, *Grossarth* sub Dinter 2698 and *Dinter* 2790 a, shows that the inner corona-lobes are inconspicuous as in *B. arnotii*. They are represented by inwardly inclined cushion-like swellings between the outer corona-lobes and are pressed against the base of the filaments. No significant difference between the two concepts was discerned.

Specimens in PRE which have also been identified with *B. arnotii* are *Bradfield* 350 from the Waterberg of South West Africa and *H. Hechter* sub PRE 30681 from between Windhoek and Gobabis (cult. Uitenhage, South Africa).

Brachystelma blepharanthera *H. Huber* in Mitt. Bot. München 4 : 33 (1961); Prodr. Fl. S.W. Afr. 114 (1967), partly, as to *Dinter* 410, 680 and 1514, excl. *Story* 6400.

Belpharanthera dinteri Schltr. in Bot. Jahrb. 51 : 146, Fig. 2, A-F (1913).

Blepharanthera edulis Schltr. l.c. Fig. 2, G-M (1913).

Since the two epithets *dinteri* and *edule* had already been created for other species in *Brachystelma*, Huber gave the new name *blepharanthera* to cover the combined concept. It was only in his second publication (1967) that he cited *Story* 6400 under his *blepharanthera*, but the *Story* specimen has a cupular outer corona and reduced inner corona-lobes, quite unlike typical *B. blepharanthera*. *Story* 6400 is specifically equal to *Dinter* 2699 in its greater part in the S.A. Museum Herbarium and is designated as the holotype of the species described below under the epithet *cupulatum*.

Brachystelma circinatum *E. Mey.*, Comm. 196 (1836); N.E. Br. in Fl. Cap. 4. 1 : 858 1908).

B. filiforme Harv., Thes. Cap. 1 : 58, t. 93 (1859); N.E. Br., l.c. 856 (1908).

B. ovatum Oliver in Refug. Bot. 4 : t. 226 (1870); N.E. Br., l.c. 860 (1908).

B. cinereum (Schltr.) N.E. Br., l.c. 862 (1908).

B. galpinii (Schltr.) N.E. Br., l.c. 860 (1908).

B. pallidum (Schltr.) N.E. Br., l.c. 861 (1908).

B. undulatum (Schltr.) N.E. Br., l.c. 859 (1908).

B. zeyheri (Schltr.) N.E. Br., l.c. 855 (1908).

Dichaelia forcipata Schltr. in Bot. Jahrb. 51 : 145 (1914); Dinter, Neue Pfl. S.W. Afr. 27, t. 10 (1914).

Many attempts at the National Herbarium to distinguish clearly between the several species recognised by N. E. Brown l.c. (1908), within the *B. circinatum* complex, have failed. Consultation with Mr. A. A. Bullock of Kew in 1966 revealed that he had experienced similar difficulties and, although he favoured the retention of the generic status of *Dichaelia* Schltr. for species with united corolla-tips, he held the view that *B. pallidum* (Schltr.) N.S. Br., *B. galpinii* (Schltr.) N.E. Br., *B. ovatum* Oliver, *B. bolusii* N.E. Br., and *B. commixtum* N.E. Br. are not specifically distinct from *B. circinatum* E. Mey. In agreeing with Mr. Bullock, the question arose whether or not to go further and reduce the specific status of *B. undulatum* (Schltr.) N.E. Br., *B. filiforme* Harv., and *B. zeyheri* (Schltr.) N.E. Br. A good range of material from the type localities is not available for further assessment but the characters relied upon for distinction by the authors are unconving in the light of our knowledge of natural variability.

Several specimens from South West Africa conforming to the description and illustration of *Dichaelia forcipata* Schltr. have been received at the National Herbarium, and they too agree with *Brachystelma circinatum* in essential characters. The decision to accept *Dichaelia forcipata* as a synonym of *B. circinatum* E. Mey. gives the species a very wide range of distribution from the eastern Cape Province northwards to the Transvaal and westwards to the northern parts of S.W. Africa.

It goes without saying that the concept of *B. circinatum* becomes a very broad one, and is even broader than the sum total of the above synonyms, because of the inclusion of yet other forms in the Transvaal, one with longer

corolla lobes, *Galpin* 9150, from a ravine near Potgietersrust and *Schlieben* 7627, from the Soutpansberg, with flat leaves, thickly pubescent on both surfaces.

Brachystelma cupulatum *R. A. Dyer,* sp. nov. nulla affinitate manifesta, corolla 6-9 mm longa viridi, corona exteriore cupulata 1.5-2 mm alta., lobis interioribus parvis pulvinatis valde insignis.

Herba tuberosa erecta simplex vel parum ramosa, 8-15 cm alta, breviter pilosa, pilis decurvis; tuber depressum, circiter 10 cm diam. *Folia* ovata, lanceolata, elliptica vel linearia, 3-8 cm longa, 4-5 mm lata, breviter petiolata, in superficiebus ambabus breviter pilosa. *Flores* plures extra axillares, pedicellis 2-3 mm longis; calyx sparse pilosus segmentis ovatis vel lanceolatis 1.5-2 cm longis. *Corolla* viridis, 6-9 mm longa, extus sparse pilosa intus glabra, tubo 1.5-2.5 mm rariter 3 mm longo, lobis plus minusve oblongis attenuatis vel lineari-lanceolatis, marginibus leviter recurvis. *Corona* exterior cupulata circiter 2 mm alta, margine 5-emarginato, lobi interiores 5 pulvinati antheris oppositi.

Type: S.W. Africa, Grootfontein, about 8 km west of Aha Mts., sandy grasslands, *Story* 6400 (PRE, holo.).

Tuber up to about 10 cm in diam., compressed from above and below. *Stem* single or once-branched near the base and sparsely above, up to 15 cm tall, sparsely hairy with decurved hairs. *Leaves* ovate, lanceolate, elliptic or linear, 3-8 cm long, 0.4-1.5 cm broad, contracted at base into a short petiole, shortly pubescent on both surfaces. *Flowers* several together, extra-axillary, opening successively; pedicels 2-3 mm long. *Calyx* with sepals ovate to lanceolate, 1.5-2 mm long, sparsely hairy. *Corolla* green, 6-9 mm long, thinly hairy on outer surface, glabrous within; tube 1.5-2.5 mm rarely up to 3 mm long; lobes more or less oblong, slightly narrowed to apex, with slightly recurved margins. *Corona* arising about 0.5 mm above base of staminal column; outer-corona cupular, about 2 mm high and much exceeding the staminal column, sometimes with 5 slits 0.5 mm deep on rim alternating with the inner corona-lobes and 5 small notches above (opposite) the inner corono-lobes cushion-like, arising from near base of inner wall of outer corona and pressing on base of filaments. *Pollinia* about 0.25 mm diam. compressed, translucent on upper half of inner margin, with short connectives from about middle, attached to small carrier.

S.W. Africa. — Grootfontein: about 8 km (5 miles) west of Aha Mts., sandy grasslands, *Story* 6400. Rehoboth: *Dinter* 2699, for the greater part, cult. Okahandja. Windhoek: between Windhoek and Gobabis at Witvlei, *H. Hechter* sub PRE 30682, cult. Uitenhage.

Dinter may have distributed a mixture of species under his number 2699 but it is more likely that the mixing which took place happened inadvertently later. All but one twig on the three sheets with that number in the S.A. Museum collection, although differing in the shape and texture of their leaves, are growth forms of the one species. The epithet *cupulatum* is given in reference to the cup-shaped outer corona. The foreign twig on one of the sheets mentioned is *B. blepharanthera* Huber, equal to *Dinter* 410 & 680.

Brachystelma dinteri *Schltr.* in Bot. Jahrb. 51 : 144 (1913); Dinter, Neue Pfl. S.W. Afr. 15, Fig. 7 (1914); H. Huber in Prodr. Fl. S.W. Afr. 114 : 12 (1967).
B. brevipedicellatum Turrill in Kew Bull. 1922 : 29 (1922).
B. ringens E. A. Bruce in Flow. Pl. Afr. 28 : t. 1096 B (1951).

The syntype numbers are *Dinter* 775, 1515, 1890 and 2384, the last two being represented in the S.A. Museum collection. They are matched very closely by *Hechter* sub PRE 30680, cultivated in Uitenhage from tubers collected near

Witvlei, between Windhoek and Gobabis. The coronal structure of these and of the concepts described by Turrill and Bruce as *B. brevipedicellatum* and *B. ringens* respectively, are very similar. Identified with these also are specimens collected in the Transvaal, Pretoria district, near Hammanskraal, by *D. S. Hardy* 2205, 2210; Waterberg district, per *W. J. Louw* sub PRE 30679; and Letaba district, east of Tzaneen, by *B. van Zyl* sub PRE 28904 (cult.). Plants come into flower at an early age as seen in *B. ringens* and the leaf formation, their texture and pubescence show considerable variation according to the conditions of growth. The present records give the species a considerable extension of distribution from S.W. Africa to the Northern Cape Province and Transvaal.

Brachystelma stenophyllum *(Schltr.) R. A. Dyer,* comb. nov.

Siphonostelma stenophyllum Schltr. in Bot. Jahrb. 51 : 148, Fig. 3 A—E (1913); Dinter, Neue Pfl. S.W. Afr. 49, Fig. 37 (1914); H. Huber in Prodr. Fl. S.W. Afr. 114 : 53 (1967).

The isotype of *Dinter* 2361 in the S.A. Museum Herbarium shows that the original figure is inaccurate in the proportion of corolla-tube to corolla-lobes; the lobes are appreciably longer than the tube and the tube is more campanulate than depicted in the figure. It is agreed, as interpreted by Phillips in his Genera, ed. 2 : 607 (1951), that *Siphonostelma* should be regarded as a synonym of *Brachystelma.* Both Dinter and Huber compare the species with *Ceropegia pygmaea,* but the affinity is certainly only remote. The corona is comparable to that in *B. cupulatum* described above.

The distribution range of *B. stenophyllum* is extended into the Transvaal by the identification with it of *Galpin* M 217, from the Waterberg, and *Hardy* 2206, from north of Pretoria.

Two New Species from Natal

In September 1965 Mr. J. Vahrmeijer, of the Botanical Research Institute, undertook a collecting expedition to some little explored parts of Zululand. Among many interesting records, two somewhat diminutive species of *Brachystelma* proved to be undescribed.

Brachystelma tenue *R. A. Dyer,* sp. nov., *B. circinatae* E. Mey. affine sed pilis spatulis longis, pedicellis longioribus et tenuioribus, sepalis longioribus differt.

Herba tuberosa humilis hirsuta e basi ramosa, ramis 5-10 cm altis, 0.75-1.25 mm diam. *Folia* breviter petiolata, ovata, ovato-elliptica vel oblongo-elliptica, 1-2 cm longa, 1.5-5 mm lata, infra sparse hirsuta, supra glabra. *Flores* extra axillares singuli vel bini, gracili-pedicellati, pedicellis hirsutis 8-10 mm longis, 0.25 mm diam. *Calyx* sparse hirsutus 5-partitus, segmentis linearibus acuminatis 3 mm longis. *Corolla* luteo-fusca, plus minusve 1.5 cm longa extus sparse hirsuta intus glabra, basi in tubum 1 mm longum connata, segmentis e basi ovatis linearibus erectis, apice cohaerentibus. *Coronae lobi exteriores* circiter 0.75 mm longi, profunde bilobati, lobulis filiformibus; lobi interiores ovato-oblongi, antheris incumbentibus aequilongis.

Type: Natal, Ubombo-Ingwavuma border, near Lala Nek, about 3 km from sea, open veld, *Vahrmeijer* 1049 (PRE, holo.).

Tuber red, up to about 4 cm in diam., slightly compressed. *Stem* sparsely branched from the base and sometimes above; branches erect or somewhat straggling, 5-10 cm long, slender 0.75-1.25 mm diam., with spreading transparent

PLATE 1.—A, **Brachystelma tenue**. B, **B. vahrmeijeri**.

hairs 0.5-1 mm long. *Leaves* opposite, shortly petiolate or subsessile, ovate, ovate-elliptic, or oblong-elliptic, 1-2 cm long, 1.5-5 mm broad, thinly hirsute on the back and margins, glabrous or with very few scattered hairs on upper surface. *Flowers* 1 or 2 produced laterally at the nodes, opening together, subtended by filiform bracts about 1.5 mm long; pedicels slender, 8-10 mm long, 0.25 mm diam., soon enlarging up to 1 mm diam. after fertilization. *Sepals* linear, 3 mm long, sparsely hairy. *Corolla* yellowish-brown, about 1.5 cm long, cage-like, sparsely hairy on outer surface; tube more or less saucer-shaped, 1 mm deep, slightly recurved at the sinuses; lobes ovate at base, linear above and united at the tips. *Corona* arising from about the middle of the staminal column; outer-lobes about 0.75 mm long, deeply divided into 2 filiform horns, slightly overtopping the staminal column; inner corona-lobes ovate-oblong, incumbent on the backs of the filaments and about equal in length. *Pollinia* somewhat pyriform 0.25 mm long, slightly compressed, with short translucent wing on upper $\frac{1}{4}$ of the inner margin, with short connectives about the middle attached to the small wingless carrier.

Brachystelma vahrmeijeri *R. A. Dyer*, sp. nov., *B. flavido* Schltr. affine sed corollae tubo longiore, lobis latioribus, corona exteriore cupulata differt.

Herba tuberosa basi ramosa usque 10 cm alta; tuber rubrum leviter compressum, usque 5 cm diam.; rami recti minute pubescentes vel glabrescentes. *Folia* plus minusve elliptico-lanceolata, usque 3 cm longa, 7 mm lata, glabra vel nonnunquam minute et sparse ciliate, breviter petiolata vel subsessilia. *Flores* 2-3 extra axillares, pedicellis 5-10 mm longis; calyx glaber segmentis lineari-lanceolatis vel lanceolatis, 2.5 mm longis. *Corolla* plerumque flavo-virens plus minusve 8 mm longa, glabra, tubo 3 mm longo infundibuliformi, lobis ovato-triangularibus 5 mm longis, basi 2.5 mm latis. *Corona* exterior cupulata circiter 1 mm alta, 1.5 mm diam., margine minute 10-emarginato, lobi interiores ovato-oblongi, antheris leviter incumbentibus.

Type: Natal, Ubombo-Ingwavuma border, near Lala Nek, about 3 km from sea, open veld, *Vahrmeijer* 1050 (PRE, holo.).

Tuber red, up to about 5 cm in diam., slightly compressed from above and below. *Stems* several from the centre of the upper surface, up to about 10 cm tall, rarely rebranched above, minutely pubescent or glabrescent. *Leaves* more or less elliptic-lanceolate, up to 3 cm long, 7 mm broad, the lowest smaller, glabrous on upper and lower surfaces, sometimes remotely and minutely ciliate on margin, contracted into a short petiole or subsessile. *Flowers* 2-3 together, extra axillary, the oldest uppermost and opening in succession; pedicels 5-10 mm long, subtended by short linear-lanceolate bracts. *Calyx* with sepals linear-lanceolate to lanceolate, 2.5 mm long, glabrous. *Corolla* yellowish-green or cream, rarely white or somewhat maroon, glabrous, 8 mm long; tube 3 mm long, funnel-shaped, 4 mm diam. at mouth; lobes ovate-triangular, 5 mm long, 2.5 mm broad at base, somewhat spreading and somewhat fleshy. *Corona* arising very slightly above base of staminal column; outer corona cupular, 1 mm high, 1.5 mm diam., twice as high as the staminal column, shallowly 10-notched or subentire, with few long hairs within; inner corona-lobes arising about halfway down inner wall of outer corona, linear-oblong, incumbent on back of filaments but not as long as them. *Pollinia* about 0.25 mm diam., somewhat pyriform, compressed, with narrow translucent margin $\frac{3}{4}$ length of inner margin, with short connectives from near base to small wingless carrier.

Bothalia 10, 2 : 379-383

A Further New Species of Cycad from the Transvaal

by

R. A. Dyer

Encephalartos cupidus *R. A. Dyer*, sp. nov., planta pygmaea foliolis plus minusve glaucis, marginibus utrinque 2-5-spinosis, megasporophyllorum vulticulo terminali 2.5-3 cm lato, 1.5-2 cm alto distinguitur.

Planta solitaria vel basi ramosa, truncis usque 75 cm altis cylindricis 20-30 cm diam. *Folia* plus minusve glauca lineari-oblonga prope basin attenuata, circa 1 m longa, foliolis infirmis 1-3 spinosis reductis, petiolorum basibus lanatis glabrescentibus sed pulvinis extus permanente lanatis, foliola mediana lineari-lanceolata acuminata 10-15 cm longa, rariter usque 19 cm, 10-13 cm lata, pungentia, marginibus utrinque 2-5-spinosis. *Strobilus masculinus* subcylindricus usque 18 cm longus, 5 cm latus, pedunculo 5-10 cm longo, microsporophylla congesta, mediana 2.2-2.5 cm longa, 1.7-1.9 cm lata; bulla glabra circa 5 mm prominens; vulticulus terminalis, circa 4.5 $\times$ 4.5 mm. *Strobilus femineus* immaturus glaber ovoideus, 18-20 cm longus, 10 cm latus; megasporophylla mediana circa 3 cm longa; bulla 3.5-4 cm lata, circa 2.5 crassa, 5-8 mm longa; lobi 2 laterales incurvi circa 5 mm longi; vulticulus terminalis 2.5-3 cm latus, 1.5-2 cm altus, margine paulo prominenti.

Type: Transvaal, Pilgrim's Rest Division, cultivated at White River, *D. van Heerden* sub PRE 30546 (PRE, holo.).

Plants unbranched or branched from the base, up to about 75 cm tall, 20-30 cm in diam., covered by alternate series of leaf-bases and bracts; bracts about 5 cm long, lanceolate, acuminate, whitish woolly on outer surface. *Leaves* about 1 m long, linear to narrowly oblong in general outline, slightly narrowed to apex and to base; rhachis more or less straight or spreading and curved, with the tip up-turned rather than recurved, more or less glaucous-green; pulvinus about 3.5 cm broad and long, woolly on outer surface; petiole-like base 4-8 mm long, up to 10 mm diam., tomentose when young, glabrescent; leaflets more or less glaucous-green, inserted up to 3 cm apart towards base, usually closer and more crowded in the upper half and often slightly overlapping, in V disposition from rhachis, reduced to 2-3 prickles at the base; median leaflets linear-lanceolate, more or less equal-sided, curved slightly upwards, 10-15 cm long, rarely up to 19 cm, 10-13 mm broad, about 17-nerved, usually with both upper and lower margins with 2-5, rarely more, forward-directed sharp prickles about 4-7 mm long and terminating in a single prickle or rarely with 2-3 subequal apical prickles. *Cones:* male and female apparently usually solitary from apex of stems, dissimilar, glabrous. *Males cones* (nearly mature, slightly dried out) with peduncle 5-10 cm long, subcylindric, about 18 cm long, 5 cm diam. about the middle, narrowed to apex and base; median scales spreading at right angles to axis, congested, 2.2 cm long, 1.7 cm broad; cuneate at base, with

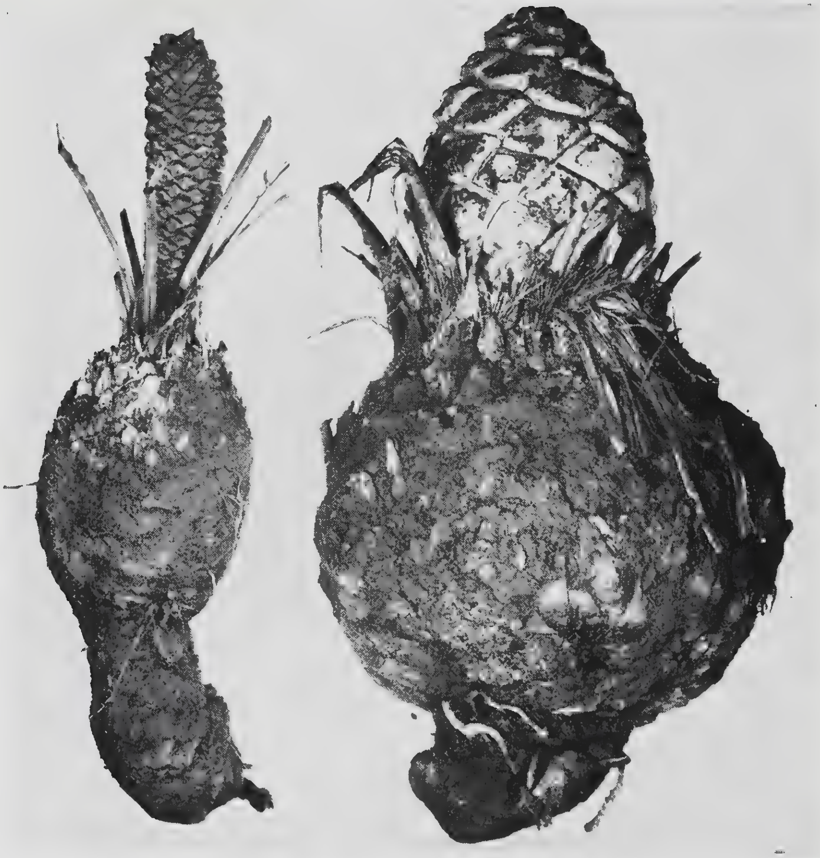

PLATE 1.—**Encephalartos cupidus:** left, male stem with cone (PRE 30546a); right, female stem with cone (PRE 30546b).

microsporangia extending to margins and 3-5 mm from terminal facet; upper surface more or less flat with indication of keel, becoming minutely honeycombed on drying; bulla glabrous, projecting about 5 mm, up to 1.7 cm broad, 6-7 mm thick vertically; upper facet humped in centre with narrow shoulders; lower facet is a continuation of the sporangial surface; terminal facet 4-5 mm broad and 4-5 mm wide vertically, slightly concave. *Female cones* (immature) 18-20 cm long, about 10 cm in their greatest diam., slightly narrowed to apex, glabrous, bright apple-green, with short stout peduncle, subtended by slender woolly bracts; median scales about 3 cm long; bulla protruding 5-8 mm, 3.5-4 cm broad, about 2.5 cm thick vertically, with lateral ridges extending into incurved lobes about 5 mm long clasping the seeds, with the median clasping lobe broadly rounded (extension of upper facet); upper facet irregularly shaped, sometimes with 1 or 2 indistinct ridges, sometimes more or less rounded, fairly

PLATE 2. — **Encephalartos cupidus,** young plant producing suckers from base (PRE 30546c).

smooth; lower facet receding more or less at right angles from the terminal facet; terminal facet irregular in shape; 2.5-3 cm broad, 1.5-2 cm wide vertically, fairly smooth, with slightly raised rim; seeds immature.

TRANSVAAL. — 2430 DA (Pilgrim's Rest Division): cultivated at White River, *D. van Heerden*, sub PRE 30546; PRE 30546a (male cone); b (female cone); c (small plant); Blyde River Nature Reserve (farm Steenveld). *Alberts*, Nature Conservation Officer, sub PRE 30545a (male plant); b (female plant); c (sterile plant).

The first evidence received of the present new species was a leaf sent to the Botanical Research Institute, Pretoria, by Mr. J. S. Oliver from a plant in cultivation in the garden of Mr. David van Heerden of White River. The

parent plant had originated some time back from the farm Steenveld on the border of the Pilgrim's Rest and Lydenburg districts in the eastern Transvaal. The area has since been incorporated in the Blyde River Nature Reserve.

Between Mr. van Heerden and Nature Conservation Officers of the Transvaal Province, and Dr. Leistner of the Botanical Research Institute, sufficient material has been made available for a fairly full description to be prepared. So far, however, only 2 immature female cones have been seen. They agree closely in essential characters and have a conspicuously large terminal facet to the scales. These, together with its dwarf habit, somewhat glaucous leaves and strongly prickly leaves, distinguish the species from among its southern neighbours. On the characters mentioned, its nearest relative appears to be *E. munchii* Dyer & Verdoorn, described from south of Vila Pery in Mozambique. The latter species, however, has far larger cones, the males of which are more than one on a plant, tall and lax.

PLATE 3.—**Encephalartos cupidus,** plant in natural habitat in Blyde River Nature Reserve, Eastern Transvaal.

The full distribution range of *E. cupidus* has not yet been surveyed but it is likely to be of strictly limited extent. The colony which was investigated by Mr. G. Alberts on the farm Steenveld covers a few square miles and consists of approximately 120 specimens. The locality is still rather inaccessible and the terrain very rough, as indicated by the name of the farm meaning stony ground.

Astonishment was expressed in 1964, when first describing *Encephalartos inopinus* R. A. Dyer, that an undescribed species of this remarkable genus should be discovered at this comparatively late stage in the botanical exploration of southern Africa. And now, five years later, another undescribed species has been brought to light.

So great is the interest in specimens of *Encephalartos* to adorn gardens, both public and private, that the specific epithet given here, meaning 'desirous' could be applied in its good sense to any species of the genus. However, the strict protective laws and penalties designed to ensure the sanctitiy of plants in their native habitats are, in fact, insufficient to safeguard plants or to deter some collectors. Thus unfortunately the tarnished meaning of the specific epithet implying a passionate desire, to the extent of greed or lust, would also be appropriate on occasions. At the same time it is well to remember that protective laws should not impede the bringing to light of new scientific information and this should be borne in mind by those empowered to administer regulations for Nature Conservation.

Bothalia 10, 2 : 385-401

Acacia karroo in Southern Africa

by

J. H. Ross

Abstract

Reasons for adopting the name *Acacia karroo* Hayne are considered and the nomenclature and synonymy are dealt with. A broad description of the species is provided. The relationship of *A. karroo* to the closely related *A. seyal* Del., *A. hockii* De Willd. and the glandular podded *Acacia* species is mentioned. *Acacia karroo* Hayne, which is the most widespread *Acacia* in southern Africa, is an extremely variable species which occupies a diverse range of habitats. The range of variation within *A. karroo,* and in particular in Natal, is considered. At least six entities are recognizable within *A. karroo* in Natal. The nature and range of variation within these entities is considered. No infraspecific categories are recognized within *A. karroo.*

The southern African *Acacia* species for which the correct name is now known to be *Acacia karroo* Hayne often forms a conspicuous feature of the landscape in the western Cape where it is the only *Acacia* to be seen for miles. On account of its occurrence in proximity to Cape Town it was the first *Acacia* encountered by early travellers in the interior of southern Africa. A number of these travellers (Simon van der Stel, Barrow, Lichtenstein, Sparrman, Thunberg and later Burchell) mentioned the plants in the accounts of their journeys and collected specimens which were later sent to Europe. This was ultimately responsible for some of the confusion concerning the correct name for this species.

Mimosa nilotica Burm. f., Prodr. Fl. Cap. 27 (1768), is apparently the earliest name applied to this southern African *Acacia.* For this species Burman quoted a figure published by Plukenet in his Phytographia, t. 123, Fig. 1 (1691) and mentioned that there were dried specimens preserved. Examination of Plukenet's figure, which consists only of a small vegetative shoot, shows that the leaflets are far too large for *Mimosa nilotica* L. (Sp. Pl. 521, 1753) whilst it is known that *M. nilotica,* or to give it its correct name, *Acacia nilotica* (L). Willd. ex Del., does not occur in the Cape. Verdoorn in Bothalia 6 : 409 (1954) mentions having received photographs of the only two *Acacia* specimens in Burman's collection from Prof. Baehni, Director of the Conservatoire et Jardin Botaniques, Geneva. One specimen is a seedling that cannot be identified with certainty. The other specimen has written on it "*Mimosa nilotica* Linn." and "Plukn. Tab. 123. Fig. 1". The name *Mimosa capensis* was later written over *Mimosa nilotica.* This specimen of Burman's is certainly referable to what is now known as *Acacia karroo* so it is evident therefore that *Mimosa nilotica* was a wrong identification by Burman.

Mimosa nilotica Thunb., Prodr. Pl. Cap. 92 (1800) was also an incorrect identification. This is clarified by Barrow in his Travels : 89 (1801) where he pointed out that the Swedish travellers (Sparrman and Thunberg) had erroneously called the Karroo Mimosa the nilotica, or that which produces the gum Arabic.

Mimosa capensis Burm. f., Prodr. Fl. Cap. 27 (1768), was based on a figure published by Plukenet in his Phytographia, t. 123, Fig. 2 (1691). However, Linnaeus referred to this same figure for his *M. reticulata* L., Mant. 1 : 129 (1767), and added to it a description of a plant from the Upsala garden with a flat reticulate pod. Linnaeus's description of the pod is quite at variance with the pod figured by Plukenet. Unfortunately Plukenet's illustration cannot be identified with any South African species of *Acacia* with certainty. Both names based on Plukenet t. 123, Fig. 2, that is *Mimosa capensis* and *M. reticulata*, must therefore be rejected as there is no preserved dried specimen of either species and as the figure cannot be identified.

Burchell in his Travels, 1 : 114 (1822), used the name *Acacia capensis* B. for the Karroo-thorn-tree but did not give a Latin diagnosis as was his custom with a new species. This suggests that Burchell was making a new combination but nowhere does he confirm this. He provided an unmistakable description of the plant on page 189 and there is a vignette of it on the same page. However, Bentham, who worked with Burchell on his Leguminosae, wrote in Trans. Linn. Soc. 30 : 507 (1875) "Burchell adopted the name *A. capensis* for this species, supposing it to be the *Mimosa capensis* Burm., Fl. Cap. Prodr. 27, which it probably is." Burchell's name, which is the combination in *Acacia* based on *Mimosa capensis* Burm. f., must therefore also be rejected.

Jacquin's plate of *Mimosa leucacantha*, Hort. Schoenbr. 3 : 75, t. 393 (1798), provided the first readily identified illustration with a definite name but the combination of the epithet with *Acacia* is rendered inadmissable by *A. leucacantha* Vatke in Oesterr. Bot. Zeitsch. 30 : 276 (1880) for an entirely different species.

For many years *A. karroo* was incorrectly called *A. horrida* (L.) Willd. Hillcoat and Brenan in Kew Bull. 13 : 39-40 (1958), in establishing the true identity of *A. horrida* (L.) Willd., explain how the name "*Acacia horrida*", which was originally based on a quite distinct Indian species (*Mimosa horrida* L., Sp. Pl. 521, 1753), was gradually accepted as the correct name for this South African species.

Acacia karroo was described by Hayne in Arzneyk. Gebr. Gewächse 10 : t. 33 (1827). Hayne stated that his illustration was made from a specimen named *Acacia vera* in the Willdenow Herbarium (No. 19184 fol. 2) and from another specimen which he received from the Cape. The Director of the Botanischer Garten und Museum, Berlin-Dahlem, to whom I am very grateful, sent me a photograph of this specimen from Willdenow's Herbarium. I have not succeeded in tracing the other specimen mentioned by Hayne. Examination of the labels on this sheet from the Willdenow Herbarium (No. 19184 fol. 2) reveals that the specimen was initially called *Mimosa nilotica. Mimosa nilotica* was subsequently erased on the one label and "*Acacia vera*" was written over it in dark ink. *A. vera* Willd. (Sp. Pl. 4 : 1085—1806) is given as a synonym of *A. arabica* (now *A. nilotica* (L.) Willd. ex Del.) by Bentham in Trans. Linn. Soc. 30 : 506 (1875). From Willdenow's description of *A. vera* it is clear that Bentham's decision was correct. It is quite certain that this specimen from Willdenow's Herbarium (No. 19184 fol. 2) is not referable to *A. nilotica* for the leaflets are far too large for that species. The name "Vieweg" also appears on one of the labels. Wagenitz in Willdenowia Bd. 3, Heft 1 : 109-136 (1962) mentions that the name "Vieweg" occurs frequently on specimens and on covers in the Willdenow Herbarium. Because of this frequent appearance of the name "Vieweg" it might be concluded that Vieweg was the collector of these plants. Specimens from as far afield as North America, Jamaica, Europe and particularly from the Mediterranean area, plus 100 specimens from South Africa bear

the name "Vieweg". Despite this, nothing much is apparently known about Vieweg and there is no evidence that he was a collector. Nobody could have travelled so extensively before 1800 and yet have remained so unknown. Vieweg was apparently the owner of an Herbarium hence the appearance of his name on so many specimens. It is thought that Vieweg handed the specimens on to Willdenow who then described them. Unfortunately Willdenow seldom gave the name of the collector when describing species. There is no record of where the specimen No. 19184 in the Willdenow Herbarium was collected. Although one of the labels reads "Habitat in Aegypto. Arabia fi" I know of no species from North Africa to which the specimen could be referred. However, the specimen is a very good match of a number of specimens that I have examined from the Cape. This close resemblance of the specimen in the Willdenow Herbarium (No. 19184) to many other Cape specimens suggests strongly that the specimen was collected in the Cape and that the phrase "Habitat in Aegypto. Arabia fi" does not refer specifically to this specimen but rather to the species *A. nilotica* and is taken either from Linnaeus' description of *Mimosa nilotica* or from Willdenow's *Acacia vera*. Presumably either specimen No. 19184 or the other species mentioned by Hayne was collected in the Karoo, whence the specific epithet for this species. *Acacia karroo* Hayne is therefore the earliest valid name for this common southern African *Acacia*.

A. karroo was introduced into Mauritius and became naturalized there. It was erroneously identified as *Mimosa eburnea* L.f. by Bojer and was listed under the name in his Hort. Maurit. 115 (1837).

A. karroo *Hayne*, Arzneyk. Gebr. Gewächse 10 : t. 33 (1827); Glover in Ann. Bolus Herb. 1 : 150 (1915); Burtt Davy in Kew Bull. 1922 : 328 (1922); Marloth, Fl. S. Afr. 2 : 51 (1925); Bak. f., Leg. Trop. Afr. 843 (1930); Burtt Davy, Fl. Transv. 2 : 346 (1932); Henkel, Woody Pl. Natal 229 (1934); Gerstner in J.S. Afr. Bot. 14 : 19-27 (1948); Codd, Trees & Shrubs Kruger N. Park : 44, fig. 38h & i (1951); Miller in J.S. Afr. Bot. 18 : 22 (1952); Verdoorn in Bothalia 6 : 409 (1954); Fl. Pl. Afr. 31 : t. 1220 (1956); Palmer & Pitman, Trees of S. Afr. 157-159, Pl. 36, 37 (1961); White, For. Fl. N. Rhod. 85, fig. 18D (1962); v. Breitenbach, Indig. Trees S. Afr. 2 : 298 (1965); de Winter *et al.*, Sixty-Six Tvl. Trees 50-51 (1966); Schreiber in Prod. Fl. S.W. Afr. 58 : 9 (1967). Type: Herb. *Willdenow* 19184 (B, lecto.; PRE, photo.).

Mimosa nilotica sensu Burm. f., Prodr. Fl. Cap. : 27 (1768), non L.

M. capensis Burm. f., Fl. Cap. : 27 (1768), pro parte.

M. leucacantha Jacq., Hort. Schoenbr. 3 : 75, t. 393 (1798), non *Acacia leucacantha* Vatke (1880).

Acacia horrida sensu Willd., Sp. Pl. 4, 1082 (1806), pro parte, quoad Jacq. fig.; sensu auct. mult. : *E. Mey., Comm. 1 : 166 (1835); Harv. in Fl. Cap. 2 : 281 (1865); Benth. in Trans. Linn. Soc. Lond. 30 : 507 (1875); Engl. in Bot. Jahrb. 10 : 23 (1888); Marloth in Trans. S.A. Phil. Soc. 5 : 270 (1889); Fourcade, Report on Natal Forests : 106 (1889); Schinz in Mém. Herb. Boiss. 1 : 113 (1900) quoad *Marloth* 1334, excl. specim. *Lüderitz* 122 [The identity of *Lüderitz* 122, which I have not seen, is in some doubt as Schinz cited it as *A. horrida* on

* As mentioned earlier the name "*A horrida* (L.) Willd." was widely misapplied to this common southern African *Acacia*, the correct name of which is now known to be *A. karroo*. *A horrida* (L.) Willd. is a distinct species that is found in East Africa and Asia.

p. 113, as *A. trispinosa* Marl. & Engl. on p. 115 and as *A.* aff. *trispinosa* on p. 116]; Sim, For. Fl. Cape Col. 211, Pl. LXI (1907); Burtt Davy in Kew Bull. 1908 : 158 (1908); Sim, For. Fl. P.E. Afr. : 57 (1909).

A. capensis sensu Burch., Trav. 1 : 114, 189 (1822); Sw., Hort. Britt. 1 : 103 (1826); Colla in Mem. Acad. Torin 35 : 175 (1831); Eckl. & Zeyh., Enum. 260 (1835).

Mimosa nilotica Thunb., Fl. Cap. ed Schult. 432 (1823), non L.

Acacia hirtella E. Mey., Comm. 1 : 167 (1835); Harv. in Fl. Cap. 2 : 281 (1865); Benth. in Trans. Linn. Soc. Lond. 30 : 513 (1875). [2]Glover in Ann. Bolus Herb. 1 : 150 (1915). Type: Natal, between Umkomaas and Umlaas, *Drege* (whereabouts unknown).

A. natalitia E. Mey., Comm. 1 : 167 (1835); Harv. in Fl. Cap. 2 : 281 (1865); Benth. in Trans. Linn. Soc. Lond. 30 : 508 (1875); Burtt Davy in Kew Bull. 1908 : 159 (1908); Glover in Ann. Bolus Herb. 1 : 150 (1915); Burtt Davy in Kew Bull. 1922 : 329 (1922); Fl. Transv. 2 : 347 (1932); Gerstner in J.S. Afr. Bot. 14 : 22 (1948). Syntypes: Natal, Port Natal (Durban) and Umgeni, alt. 300 ft, *Drege* (? K, iso.); Pondoland, between Umgazana and Umzimvubu, alt. 600-1000 ft, *Drege* (whereabouts unknown).

Mimosa eburnea sensu Bojer, Hort. Maurit. 115 (1837), non L.

Acacia horrida Willd. var. *transvaalensis* Burtt Davy in Kew Bull. 1908 : 158 (1908). Syntypes: Transvaal, Pretoria district, Groenkloof, near Pretoria, *Burtt Davy* 2468 (BOL!; PRE!); Arcadia, Pretoria, *Burtt Davy* 2807 (PRE!).

A. karroo Hayne var. *transvaalensis* (Burtt Davy) Burtt Davy in Kew Bull. 1922 : 328 (1922); Fl. Transv. 2 : 347 (1932).

A. inconflagrabilis Gerstner in J.S. Afr. Bot. 14 : 24-26 (1948). Syntypes: Natal, Nongoma district, Nongoma township *Gerstner* 4562 (NBG!; NH!; PRE!); *Gerstner* 4635 (NBG!; NH!; PRE!); *Gerstner* 4637 (NBG!).

Shrub, often many stemmed, or a tree to 22 m, sometimes very slender and sparsely branched; crown rounded, often irregularly so, or flattened; trunk to 0.75 m in diameter. *Bark* dark brown, reddish-brown, brownish-black to black, rough, often fissured, or white to pale greyish-white or greyish-brown and smooth, the latter green when young and with conspicuous transversely elongated lenticels. *Young branchlets* reddish- to purplish- or blackish-brown or white to yellowish- or greyish-brown, flaking minutely or smooth, conspicuously or inconspicuously lenticellate, glabrous or sometimes sparingly pubescent, especially when young. *Stipules* spinescent, glabrous, in pairs below the nodes,

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[2] non Sim in Agric. Jour. 19 (1900); non Sim in For. and For. Fl. Cape Col.: 211, t. LIX (1907). Sim was apparently referring to *A. sieberana* DC. var. *woodii* (Burtt Davy) Keay & Brenan as evidenced by his description of the bark "yellowish white flaky" and of the pod as "4 inches long, $\frac{3}{4}$-1 inch wide, solid, indehiscent, tomentose." However, *A. sieberana* var. *woodii* seldom has only 4 pinna pairs as described by Sim and the involucel is in the upper half of the peduncle or apical and not in the lower third as illustrated in t. LIX. Sim described the inflorescence as "light yellow or nearly white" which is in contrast to the deep yellow inflorescence of *A. karroo*.

A. robusta Burch., however, which often has only 4 pinna pairs, has a whitish inflorescence and has the involucel in the lower third so it appears as though Sim's description of *A. hirtella* might possibly be taken from *A. sieberana* var. *woodii* and from *A. robusta* Burch.; non Sim in For. Fl. P.E. Afr.: 57, t. XXXV A (1909). In this instance Sim was clearly referring to *A. robusta* Burch.

straight or slightly curved, white or the same colour as the stem, usually 0.4-4.5 (-10.0) cm long, sometimes swollen and greatly elongated to 25.0 cm long, latter elongated spines usually united basally, entire plant frequently exceedingly spinescent. *Leaf:* petiole 0.5-1.8 cm long, glabrous or sometimes sparingly pubescent, adaxial gland usually present, variable in position, usually rounded or oval, at times slightly stalked, to 1.5 x 1.5 mm; rachis (0-) 1.0-4.6 (-9.0) cm long, glabrous, sometimes sparingly pubescent, abaxial surface without recurved prickles, sulcate adaxially; glands rounded or sometimes stalked, yellowish- to reddish-brown or black, between top 1–3 pinna pairs, between all pinna pairs or absent from some; pinnae (1–) 2–6 (–13) pairs; rachillae (1.0–) 1.5–3.8 (–7.2) cm long, glabrous or sometimes sparingly pubescent; leaflets 6–15 (–24) pairs, (2.8–) 3.5–8.0 (–12.5) mm long, 1.0–2.5 (–5.0) mm wide, linear, linear-oblong to obovate-oblong, base oblique, apex rounded to sub-acute or acute, margin entire, glabrous or occasionally sparingly puberulous. *Inflorescence* capitate, on axillary peduncles, fascicled or sometimes solitary, forming terminal racemes, sometimes on lateral axillary branchlets the entire inflorescence producing an irregular terminal panicle; flowers sessile, bright yellow; peduncle 0.7–2.4 (–4.0) cm long, terete, olive- or reddish-brown, glabrous, occasionally sparingly pubescent, sometimes glandular; involucel at, slightly above or below middle (down to one third) of peduncle (when the flowers are young the involucel appears to be at the apex of the peduncle, however, as the peduncle lengthens the involucel soon assumes its true position). *Calyx* deep yellow, campanulate, glabrous throughout or apices of lobes sometimes sparingly pubescent, tube 1.2–1.8 mm long, lobes up to 0.5 mm long. *Corolla* deep yellow, glabrous, tube 1.5–2.3 mm long, lobes to 0.8 mm long, reflexed, alternating with calyx lobes; stamen filaments free, up to 5 mm long, yellow; anthers with deciduous apical gland; ovary glabrous, shortly stipitate, up to 1.5 mm long; style glabrous, up to 5 mm long. *Legume* dark yellowish- or reddish-brown to brown, straightish or slightly to strongly falcate, irregularly constricted between the seeds, often distinctly moniliform, (4.4–) 5.0–10.5 (–21.0) cm long, 0.5–0.7 (–1.1) cm wide, apex rounded to acute or acuminate, sometimes attenuate at both ends, dehiscing longitudinally, subcoriaceous, venose, usually longitudinally so, often very conspicuously, glabrous, sometimes glandular, umbonate over the seeds. *Seeds* olive-brown to reddish-brown, elliptic or lenticular, sometimes ± quadrate or suborbicular, compressed, (3.5-) 4.5-6.5 (-9.0) mm x (2-) 3-4 (-7) mm wide; areole elliptic or lenticular, sometimes subcircular, 3.0-5.5 (-7.5) mm x 2.0-3.5 (–4.5) mm.

A. karroo Hayne is the most widespread *Acacia* in southern Africa (see Fig. 1). Not only is *A. karroo* widespread, but it is numerically well-represented throughout most of its range. *A. karroo,* being so widespread, has exploited many diverse habitats and is consequently an exceedingly variable species. Story in Mem. Bot. Surv. S. Afr. 27 : 28 (1952) noted: "The fact that *Acacia (A. karroo)* is South Africa's most widely distributed tree suggests strongly that it is also the least exacting in its demands, and that it would often be the first to migrate into an unfavourable area. One could also expect to find pure and permanent stands more and more strongly marked according as the areas were progressively less suited to trees — obviously as far as these areas were not too unfavourable to preclude its growth altogether." *A. karroo* has the ability to encroach rapidly into grassland grazing areas and is consequently considered a serious menace in parts of its range. Attempts to eradicate plants by chopping often result in a vigorous coppice growth. Of all the indigenous *Acacia* species, *A. karroo* appears to be subjected to the severest attacks by the wattle bagworm, *Kotochalia junodii* (Heyl.). The degree of infestation is often sufficient to kill fairly large trees.

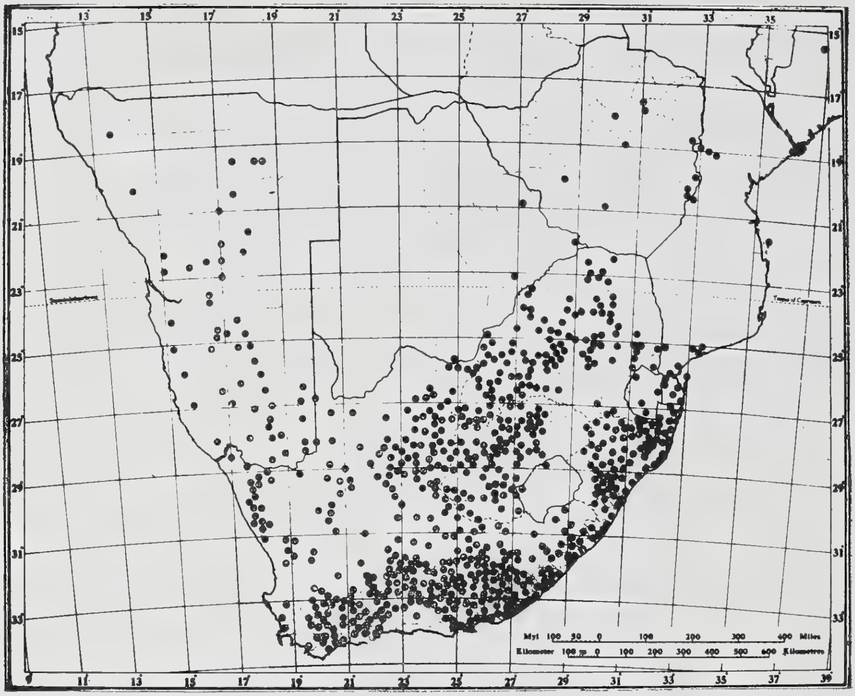

Fig. 1.— The known distribution of **A. karroo** based on an examination of herbarium specimens, field observations, on an unpublished map prepared by *Acocks* in 1965, and on *De Winter* et al. in Sixty-Six Transvaal Trees : 50-51 (1966).

Plants tend often to have a different "look" in various parts of the species geographical range. In the arid regions of the northern Cape and in South West Africa plants are confined to the banks of dry watercourses or other areas where underground water is available. In parts of the Transvaal plants are often exceedingly robust and are vegetatively easily confused with *A. robusta* Burch. In the reproductive phase, *A. karroo* is, however, readily distinguishable from *A. robusta* in having bright yellow flowers and much narrower, less woody pods.

A tendency of *A. karroo*, shared also by *A. seyal* Del., *A. hockii* De Willd., *A. nilotica* (L.) Willd. ex Del. and sometimes also by *A. davyi* N.E. Br., is for a few flowers to develop in the involucel on the peduncle, sometimes giving the appearance of a smaller secondary capitulum below the main one. The flowers in this secondary capitulum in *A. karroo* often develop before those in the main capitulum. Most of these flowers are male only although in a few flowers examined the ovary was present, but the style absent. The flowers are apparently sterile, but this needs further investigation.

The relationship of *A. karroo* to the very closely related *A. hockii* and to *A. seyal* needs careful investigation. *A. seyal* is widespread in northern tropical Africa, extending to Egypt and southwards to Zambia, Malawi and Mozambique. *A. hockii* occurs from French Guinea in west Africa to the Sudan in the north

and southwards to Angola, Zambia and Mozambique. The northern limit of distribution of *A. karroo*, therefore, corresponds roughly to the southern limits of distribution of *A. seyal* and *A. hockii*. Although all three species are found in Zambia and Mozambique their ranges scarcely overlap. Brenan in Fl. Trop. E. Afr. Mimos. : 103-105 (1959) enumerates the differences between *A. seyal* and *A. hockii* whilst White in For. Fl. N. Rhod. : 85 (1962) provides descriptions of all three species.

The glandular podded *Acacia* species (*A. borleae* Burtt Davy, *A. exuvialis* Verdoorn, *A. nebrownii* Burtt Davy, *A. permixta* Burtt Davy, *A. swazica* Burtt Davy, *A. tenuispina* Verdoorn and *A. torrei* Brenan) in southern Africa all have a close affinity to *A. karroo* and appear to have been derived from the latter during earlier times. It is not clear whether each of the above species was independently derived from *A. karroo* or whether some of the species have given rise to others. Most of the species are now fairly distinct from *A. karroo*, but certain specimens cannot be referred either to *A. karroo* or to *A. tenuispina* with certainty. *Codd* 7040 (PRE) from north of Pienaars River (Grid. Reference: 2528 AB PRETORIA) was described by the collector of "possibly a hybrid between *A. karroo* and *A. tenuispina*." Some plants have the growth form of *A. tenuispina* and agree with it vegetatively but lack the glandular pods. The two species may well hybridize but this requires careful field investigations. *Burtt Davy* 4075, 4077 (PRE) from the Springbok Flats are difficult to place. They are vegetatively very close to *A. tenuispina*, but lack glandular pods and are therefore referred to *A. karroo*.

A. karroo, therefore, is very closely related to a number of other species. It is apparently one of the least exacting in regard to habitat preference and has consequently been able to inhabit a wide range of habitats.

Before proceeding to examine the variation within *A. karroo* it is necessary to consider the value of recognizing infraspecific categories within such a widespread and variable species. Two alternatives are available: to fragment the species and accord each recognizable entity formal taxonomic status, or to recognize only one variable species with no infraspecific categories. Clearly a decision must be taken as to which of the two alternatives to follow. For ecological purposes it is useful for variants to have names for ease of reference. The significance of infraspecific "labels" is obvious in that if two variants occur in the same community the use of the same name for each will suggest a degree of similarity which may be misleading. However, the problem of identifying each entity clearly and thereby facilitating identification by other workers is often extremely difficult.

In Natal, *A. karroo* occurs from sea level to the top of the Low Berg at Van Reenen's Pass (1524 m). It is perhaps in Natal that *A. karroo* exhibits its greatest range of morphological variation. At least six entities may be recognized, namely:

1. shrubs or small trees with dark, rough bark (see Pl. 1) growing in dry thornveld or dry valley scrub;
2. large trees with dark, rough bark forming a narrow riverine fringe along the banks of streams in dry thornveld or dry valley scrub;
3. white barked trees or shrubs with short spines (*A. natalitia* E. Mey.);
4. "fire-resistant" shrubs found in northern Zululand (*A. inconflagrabilis* Gerstner);
5. slender, sparingly branched trees in Zululand (popularly termed "spindle *A. karroo*");
6. trees with whitish bark, long white spines and long, moniliform pods found along the Zululand coast.

Plate 1.—The rough, dark brown to brownish-black bark of **A. karroo.** Bisley, near Pietermaritzburg (2930 CB Pietermaritzburg), April, 1967.

The first two entities are comparable with specimens of *A. karroo* found in other areas of distribution and present no difficulty. The riverine plants are larger than those in the surrounding dry thornveld or valley scrub and consequently often enable the course of a stream to be detected from afar.

A. natalitia E. Mey.

E. Meyer, Comm. 1 : 167 (1835), described *A. natalitia* from specimens collected at "Port Natal et Omgeni . . .; inter Omgaziana et Omsamwubo . . ." by Drege. Meyer held that *A. natalitia* differed from *A. karroo* in its whitish and not blackish bark, in its spines being short or nearly wanting (*"aculeis saepe brevissimis et vix ullis, numquam 9 lineas longis")*, in its more numerous pinnae (4-7) and leaflet (12-18) pairs, and in its smaller and narrower leaflets. Mr. J. P. M. Brenan, Keeper of the Herbarium and Library, Royal Botanic Gardens, Kew, to whom I am extremely grateful, informed me that there is a specimen at Kew which may possibly be an isotype of *A. natalitia*. This specimen was originally in Bentham's herbarium and bears a label reading "Acacia natalitia E. M. a." plus a bibliographical reference in Bentham's hand. There is a pencil note on the sheet by Dr. N. E. Brown reading "Port Natal Umgeni 300 ft. alt." It is thought that this specimen may be part of the first Drège gathering mentioned by Meyer (l.c.). However, the label of this specimen does not bear any collector's name and it is only inference that it is part of a Drège specimen although it must have been accepted by N. E. Brown who was probably very familiar with the early collectors. The sheet bears a type specimen label. I have not succeeded in tracing the whereabouts of the other specimen mentioned by Meyer. There are, however, specimens from Port Natal (Durban) collected by *Gueinzius* (K, PRE) and *Krauss* 66 (K) which agree with the description. A further selection of specimens, for example *Ross* 802, 803 (NU) from Uvongo (3030 CD PORT SHEPSTONE) and *Ross* 806 (K, NU) from Port Edward (3130 AA PORT EDWARD), serves to establish the identity of the entity referred to *A. natalitia* by Meyer.

Meyer (l.c.) also described *A. hirtella* from a specimen collected between Umkomaas and Umlaas. The description of *A. hirtella* differed from that of *A. natalitia* in a few minor points, namely the hairiness of the leaflets in *A. hirtella*, the presence of a gland between the first and last pinna pairs as opposed to a gland between each pinna pair in *A. natalitia*, and the somewhat acute leaflet apices in *A. hirtella* in contrast to obtuse leaflet apices in *A. natalitia*. Unfortunately I have not been able to establish the whereabouts of the type specimen of *A. hirtella*. However, the specimen *Pole Evans* in *H. Medley Wood* 12014 (BOL, NH, SAM) from Winklespruit (3030 BB PORT SHEPSTONE) serves to establish the identity of the entity referred to *A. hirtella*. Gerstner in J. S. Afr. Bot. 14 : 19-27 (1948) considered *A. hirtella* to be "only a young and local variety or modification of *A. natalitia*" and consequently regarded *A. hirtella* as a synonym of *A. natalitia*.

The name *A. natalitia* has been loosely applied to the variant of *A. karroo* with white bark not only in Natal but also in the eastern Cape, the Transvaal, Swaziland and Mozambique. Burtt Davy, Fl. Transv. 2 : 347 (1932) cited several specimens of *A. natalitia* from the Transvaal, for example *Pott* 5304 (PRE) from Barberton (2531 CC KOMATIPOORT). Gerstner (l.c.), although maintaining *A. natalitia* as a distinct species, also mentioned certain specimens which he regarded as hybrids between *A. karroo* and *A. natalitia*. For example, *Gerstner* 6225 (PRE) from Chipese in the northern Transvaal (2230 CA MESSINA) which "has bark of *A. karroo*, leaves of *natalitia* . . ."

From an examination of herbarium specimens it is obvious that Gerstner studied the variation within *A. karroo* and *A. natalitia* in some detail, and over a period of years. Apparently he initially considered the variant of *A. karroo* with long spines and long moniliform pods that is found along the Zululand coast as a new species which he proposed calling "*A. psammophila.*" However, on discovering that this name had been used for an Australian species, *A. psammophila* Pritz in Engl. Bot. Jahrb. 35 : 294 (1904), he adopted the name "*A. zululandensis.*" He evidently then considered some specimens from the northern Transvaal, for example *Gerstner* 5800, 5846 (PRE) to represent a new species for which he proposed the name "*A. karrooidea* MS (= forma *suluensis* Ms)". Subsequently Gerstner united his "*A. zululandensis*" and "*A. karrooidea*" with the short-spined variants referred to *A. natalitia* by Meyer under one species which he called *A. natalitia*. *A. natalitia* in Gerstner's view in J.S. Afr. Bot. 14 : 19-27 (1948) incorporated all of the white-barked variants irrespective of their locality. The widespread application of the name *A. natalitia* for the variant of *A. karroo* with long spines and long, moniliform pods seems to originate from Gerstner's publication.

Although the pod of *A. natalitia* was unknown to Meyer, it seems quite clear to which entity he intended his "*A. natalitia*" to be applied. Meyer made special mention of the spines being very short or nearly wanting in *A. natalitia* as opposed to those of *A. karroo* as evidenced by his description. The application of the name "*A. natalitia*" for the long-spined variant with long moniliform pods seems therefore in error.

In the western and northern Cape and in the Karoo itself, *A. karroo* has usually 2-3 pinna pairs, although the range is 1-5 pairs, and 6-12 leaflets pairs. Consequently, the presence of 4-7 (up to 13 are recorded) pinna pairs and 12-18 (—24) leaflet pairs in parts of the eastern Cape, Natal, Swaziland and the eastern Transvaal suggests at first sight these characters are of importance in distinguishing the entity from *A. karroo*. However, despite this tendency of *A. natalitia* to have a greater number of pinna and leaflet pairs, when the entire range of morphological variation of *A. karroo* throughout its distributional range is examined, the differences provide no discontinuity. Consequently, *A natalitia* is not regarded as specifically distinct from *A. karroo* nor is it maintained at infraspecific rank within *A. karroo*.

A. inconflagrabilis Gerstner

Gerstner (l.c.) described *A. inconflagrabilis* from the Nongoma district of Zululand (2731 DC LOUWSBERG). *A. inconflagrabilis* was said to be always a shrub "in the mistbelt area and transition from mistbelt to grassveld and bushveld" in contrast to its nearest relations *A. karroo* and *A. natalitia* which "grow into trees and inhabit the dry bushveld." The leaflets of *A. inconflagrabilis* were said to be shiny and narrower than in the other two species although Gerstner conceded that "Purely vegetative Herbarium specimens of these two (*A. inconflagrabilis* and *A. natalitia),* if already dried, are impossible to distinguish." The type locality is an area that is usually heavily overgrazed. Consequently, the grass cover is kept very short and at times is very scant. Grass fires, therefore, do not generate so much heat and it would be interesting to ascertain whether *A. inconflagrabilis* is indeed more fire-resistant than *A. karroo,* or whether this impression is gained because plants of *A. inconflagrabilis* are never subjected to such intense heat as are plants of *A. karroo* growing in tall grassland.

A. inconflagrabilis is not considered sufficiently distinct from *A. karroo* for retention at specific rank nor at infraspecific rank within *A. karroo.*

"Spindle *A. karroo*"

Henkel in his report on the Plant and Animal Ecology of the Hluhluwe Game Reserve : 18 (1937) referred to "a dwarf or spindly form" of *A. karroo*. Henkel wrote "This (*Dichrostachys glomerata* and dwarf *Acacia karroo* association) is the most important of the lowlands associations and covers a large area, chiefly the eastern part of the lowlands." This variant of *A. karroo*, which has subsequently been widely known as "spindle *A. karroo*," is also found in the Umfolozi Game Reserve, in the corridor linking both reserves and northward to Rooirand. Plants grow typically as slender, relatively unbranched trees up to 6 m high (see Pl. 2). Typically the bark is bright reddish-brown and flaking minutely, the foliage is glaucous, the petiolar gland is large, flattened and discoid, and there is a large gland between each, or almost every pinna pair. The paired spines are usually very short although often they are completely absent. A few specimens will serve to establish the identity of this variant: *Downing* 451, 452, 453 (NH, NU) from Umfolozi Game Reserve; *Bourquin* H60307, H60308 (NH) from Hluhluwe Game Reserve.

PLATE 2.— Slender, relatively unbranched specimens of "Spindle A. **karroo**" up to 6 m high. *A. caffra (Thunb.) Willd.* in foreground, *Maytenus senegalensis (Lam.) Exell* left foreground and *Ceratotherium simum simum Burch.* centre. Hluhluwe Game Reserve (2832 AA Mtubatuba), April, 1963.

"Spindle *A. karroo*" is not as common within the Hluhluwe Reserve as "typical" *A. karroo*. However, there is a complication because "typical" *A. karroo* also tends to be slender and often only sparingly branched (see Pl. 3), especially when young, but plants ultimately become fairly well branched with a fairly

PLATE 3.—Slender, relatively unbranched young specimens of "typical" **A. karroo** up to 7 m high. **A. caffra** in foreground. Corridor between Hluhluwe and Umfolozi Game Reserves (2831 BD Nkandla), March, 1964.

dense crown (see Pl. 4). The bark on these plants, although sometimes reddish-brown, is often greyish-black with a reddish-brown inner bark and the foliage only slightly glaucous as opposed to the bright reddish-brown bark and distinctly glaucous foliage in "spindle *A. karroo*." However, these plants possess the large petiolar gland and the large glands between the pinnae exhibited by "spindle *A. karroo*" (*Ross & Moll* 1773).

On the badly overgrazed areas outside the southern entrance to the Hluhluwe Game Reserve plants grow as small, slender, often much-branched trees or shrubs up to 2 m high. These plants have bright reddish-brown bark that flakes minutely and glaucous foliage. However, the large flattened petiolar gland and the large glands between the pinnae that are usually associated with the glaucous foliage are absent whilst the peduncle and young pods are distinctly glandular and the latter somewhat viscid (*Ross & Moll* 1770).

A "spindle" growth form is also recorded (*Codd* 8435 in PRE) from near the Loskop Dam in the Transvaal (2529 AD WITBANK). This specimen differs from the Natal "spindle *A. karroo*" in leaf and in pod characters.

Growth form alone does not distinguish this variant, because nearly all of the *A. karroo* in the Hluhluwe Reserve has the slender relatively unbranched habit, especially when young. However, whereas "typical" *A. karroo* continues to grow and branch until it is a fairly large tree up to 10 m high "spindle *A. karroo*"

PLATE 4.—Fairly well branched, more mature specimens of "typical" **A. karroo** up to 8 m high growing together with more slender specimens. Hluhluwe Game Reserve (2832 AA Mtubatuba), March, 1964.

remains slender and seldom appears to attain a height of over 6 m. These slender plants are often subjected to fairly severe mechanical breakage during strong winds. *A. karroo* often grows in extremely dense, pure stands within the Reserve, individuals being apparently of similar age as if germination was stimulated simultaneously by some environmental factor such as an unseasonal fire.

Emphasis on the growth form of "spindle *A. karroo*" has masked what is probably a more important taxonomic character in attempting to distinguish the variant from "typical" *A. karroo,* namely the glaucous foliage. Leaflet shape is perhaps also important because in "spindle *A. karroo*" the leaflets are often broader in relation to their length than in "typical" *A. karroo.* However, this character provides no clear distinction when leaflet shape of *A. karroo* from the entire distributional range is examined.

Field observations within the Hluhluwe and Umfolozi Reserves indicate that "typical" *A. karroo* and "spindle" *A. karroo* are linked by a number of intermediates. In its typical form "spindle *A. karroo*" is readily recognizable, yet when an attempt is made to delimit it from "typical" *A. karroo,* great difficulty is encountered. This difficulty is especially apparent from an examination of herbarium specimens. It is appreciated that this inability to distinguish specimens in the herbarium does not, of course, imply that the field differences are of no consequence. There are undoubtedly differences, but the characters appear to vary

PLATE 5.— Tall, slender specimens of the variant of **A. karroo** with whitish bark, long spines and long moniliform pods, up to 20 m high and forming a dense community in dune forest. Undergrowth mainly **Isoglossa woodii** *C. B. Cl.* Mapelane (2832 AD Mtubatuba), Nov. 1965. Photo: E. J. Moll.

PLATE 6.—Well branched specimen of the variant with long spines and long moniliform pods, up to 5 m high and with a rounded crown. Growing on the bank of the Amatikulu river estuary in an area subject to tidal inundation. The variant is dominant on the lower slopes of the hillside in the left foreground. (2931 BA Stanger), March, 1967.

independently as inconsistent tendencies. For example, the glaucous foliage, the large petiolar gland and glands between each pinna pair appear to typify "spindle *A. karroo*." However, in some plants the glands are present but the foliage is green whilst in others the foliage is glaucous but the glands are absent. There is a gradation in leaf colour from glaucous to semi-glaucous to green. The "spindle *A. karroo*" recorded from the Transvaal has neither markedly glaucous foliage nor large glands.

It is not intended to accord "spindle *A. karroo*" formal infraspecific taxonomic status. This decision must not be taken as an indication of uniformity with *A. karroo*. The variant is considered as a local expression of an extremely variable species. In an ecological account the variant may be distinguished by reference to it as "the spindle form" and thus convey the lack of uniformity within the communities. The term "spindle" is perhaps an unfortunate one, but the term has been so widely adopted for this variant that an attempt to substitute the term with a new one would probably merely create confusion.

The variant with long spines and long moniliform pods

This variant extends northwards along the coast of Zululand from about the mouth of the Tugela River to central Mozambique, including the offshore islands of Inhaca and Bazaruto. Plants are confined to a fairly narrow belt along the coast which is often narrower than one kilometre. They grow on the coastal plain,

amongst the coast dunes, in the mouths of many river estuaries, for example, the Amatikulu, and around the shores of the fresh water Lake Sibayi. The plants, which usually form very dense, pure stands and are dominant to the exclusion of other trees, often act as pioneers in stabilising loose sand dunes, especially in disturbed areas and in patches of regenerating coast dune forest. When growing in dense communities the plants are tall, fairly slender and relatively unbranched (see Pl. 5). In the open they are well branched with rounded crowns (see Pl. 6).

The bark is typically greyish-white or whitish, fairly smooth, often lenticellate and encrusted with crustose lichens (see Pl. 7). However, on exposed plants the bark becomes at times quite dark greyish-brown and rough. On young stems the bark is typically green with numerous white, transversely elongated lenticels whilst on the very young branches it is usually smooth and whitish although it may at times be purplish. Plants are armed with white spines that are frequently large and slightly swollen and which may attain a length of 25 cm. Many plants display persistent paired spines on the trunk, a feature not observed in any of the other variants. Some plants are exceedingly spinescent, a feature which renders them conspicuous. The view has been expressed, although not in print, that the large spines are a characteristic of this variant alone and that in other areas of distribution large spines are confined to young plants, mature plants bearing small spines. This is not true, for large spines (over 10 cm long) are found on mature plants in other areas of distribution, although largest spines are admittedly found in this variant. For example, *Ross* 640 (K, NH, NU), from near Muden (2830 CD DUNDEE) has spines up to 15 cm long. The foliage is often a dark green similar to that of *A. robusta* and there is a tendency for the glands between the pinna pairs to be slightly stalked.

None of the characters mentioned is sufficient to warrant the separation of this variant as an infraspecific entity of *A. karroo*. The smooth, whitish bark is shared by the entity referred to *A. natalitia*. Indeed, it will be recalled that Gerstner united both variants under *A. natalitia*.

This variant does, however, tend to differ from "typical" *A. karroo* in having longer and broader pods that are typically almost moniliform, larger seeds, larger areoles and longer peduncles. However, in no instance does a single character provide a clear discontinuity, the characters tending rather to occupy one extreme of the range of variation of *A. karroo*.

Although the smooth bark on the young branchlets, coupled with the above tendencies may be considered sufficiently distinctive it is not intended to accord the variant formal taxonomic status. This variant, which grows on the geologically recent sands of the Zululand coast, is in its extreme form perhaps the most distinctive of all the variants within *A. karroo*. The plants are adapted to the prevailing range of environmental conditions and are probably best regarded as an ecotypic response to this habitat. Some of the characters enabling the plants to flourish are no doubt physiological and genetical and are not primarily morphological. Consequently the differences do not manifest themselves morphologically in a manner that is sufficiently distinctive to facilitate taxonomic recognition. Further investigation is necessary and sufficient grounds may ultimately be found to accord the variant formal taxonomic status.

To date only one infraspecific category has been formally recognized. Burtt Davy in Kew Bull. Misc. Inf. 1908 : 158 (1908) recognized var. *transvaalensis* within *A. horrida* Willd., the variety differing from typical *A. horrida* in being "pubescent on the younger parts." Burtt Davy failed to nominate a type specimen for var. *transvaalensis* in this paper. Subsequently, in Kew Bull. 1922 : 328 (1922),

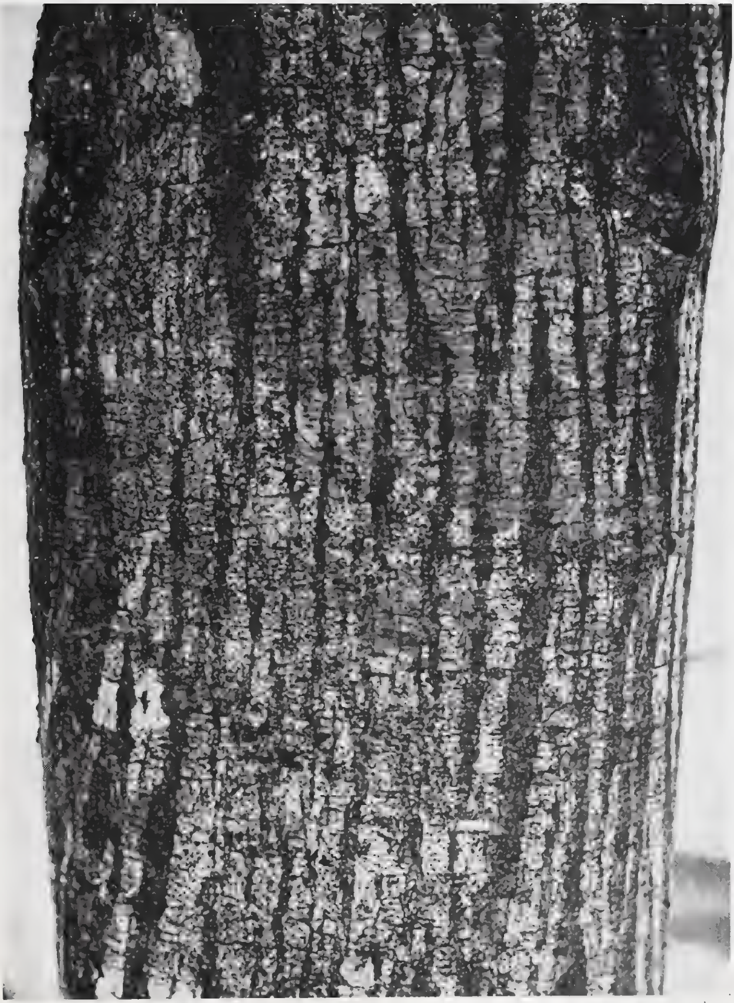

PLATE 7.— Pale greyish-white, smooth, lenticellate bark of the variant with long spines and long moniliform pods. Lake Sibayi (2732 BC Ubombo), Feb. 1968.

after learning that the correct name for the South African plants previously referred to *A. horrida* was *A. karroo,* Burtt Davy transferred his var. *transvaalensis* to *A. karroo.* He maintained his variety in Fl. Transv. 2 : 347 (1932) and it is here that he mentioned the syntypes *Burtt Davy* 2468, 2807 for the first time. The type specimens are only sparingly pubescent and this sparse development of the indumentum is not considered sufficiently distinctive to warrant recognition at varietal rank.

In this treatment *A. karroo* has been regarded as an exceptionally variable species in which no infraspecific categories have been formally recognized. Within the species numerous biotypes are recognizable, each of which varies independently but always within certain limits, the limits of each falling within the range of variation that is accepted as *A. karroo.* Some of these biotypes, for example the variant with long spines and long moniliform pods, are more distinctive than others.

The extremes of each of the variants are usually quite distinctive and naturally it is these extremes that attract immediate attention. However, it has been found that the extremes of each variant are linked to the "central *A. karroo* gene-pool" by numerous and varied intermediate stages that become progressively less and less distinct until a stage is reached where it becomes extremely difficult to assign specimens to any particular entity with any degree of certainty. It has consequently been considered of dubious value to fragment such an inherently variable species into a number of taxonomic entities. Examination of *A. karroo* suggests that the *A. karroo* gene-pool is an ancient one, and one that has continually been able to adapt itself to new habitats. *A. karroo* is apparently one of the least exacting species in regard to habitat preference, a feature that enabled the species to inhabit a diverse range of habitats.

Acknowledgements

I am very grateful to Dr. L. E. Codd, Chief, Botanical Research Institute, for some valuable suggestions, for advice and for comments; Dr. H. Schulz of the Botanischer Garten und Museum, Berlin-Dahlem, for information relating to Vieweg, and to Dr. K. D. Gordon-Gray of the Bews Botanical Laboratories, University of Natal, Pietermaritzburg, for reading and commenting on the original manuscript.

Book Review

Fundamentals of Mycology, by J. H. Burnett, 546 pp., *numerous text figures, Frontispiece and 8 plates. Edward Arnold (Publishers) Ltd. London, W1,* 1968. *Price* £6.10.0 *net* (65/- *net paper).*

The title is slightly misleading for, in a book on fundamental mycology, one would expect due attention to be given to fungal taxonomy. This branch of mycology, which has undergone important changes of approach in recent years, deserves more than the cursory treatment it receives in this book, even if one takes into account that the author's aim has been to elucidate what all fungi have in common and what makes a fungus tick. Fundamentals of mycological biology would therefore have been a more appropriate title. The author has, however, succeeded admirably in bringing together a wealth of information which has never before been available in one text book. Thus the structure of fungi, their growth and other physiological aspects, genetical phenomena, their speciation and dispersal are all dealt with at length. This comprehensiveness is a valuable feature of the book, though the review style adopted to condense as much information as possible in a book of this size, makes for exhausting reading.

The contents are divided into four broad sections, Structure and Growth, Function, Recombination, Speciation and Evolution. The first gives a detailed account of our present knowledge of hyphae and all components as elucidated by, for instance, electron microscopy. Hyphal differentiation and growth, the production of reproductive structures and spore liberation, dispersal and germination are the other main topics discussed in this section.

The second section, Function, contains chapters on the following subjects: general aspects of fungal nutrition and metabolism, transport processes in fungi, translocation and transpiration, carbohydrate catabolism, accumulated and synthetised products and their metabolism, reaction and interaction. Under the heading "reaction to environmental factors" in the last chapter I looked in vain for a reference to adaptation of fungi. An essay on this subject rather than the unnecessary detailed conflicting evidence on biochemical processes should have found a place in the book. Adaptation in fungi is of paramount importance to applied mycology which has repercussions in such diverse fields as, among others, plant protection, the soft drink industry and microbiological oceanology.

In Section III attention is drawn to the great diversity of types of somatic division and to the uniformity of meiotic divisions. The reasons for asexual variation are clearly elucidated. This section is of a very high standard as is Section IV in which an admirable expostion is given of what forces are at work which lead to speciation in fungi. The result is a genetical isolation which in fungi is of a quite different nature than in other organisms. The book closes with a chapter on phylogenetic considerations, in which weaknesses in phylogeny based on comparative morphology without considering function, are exposed.

For a book of this size it has surprisingly few typographical errors. I noted however that in Plate 1, Fig. 3 (p. 8) microfibrils are shown connecting particles with wall at left and not top of picture, and also that the publication of Emerson & Weston, 1967 (pp. 197, 198) is missing from the list of references. The illustrations are well chosen and the microphotographs are of high quality.

The outstanding feature of the book is, however, that the author repeatedly points out the gaps in our knowledge. This fills a need for leadership in mycological investigations and thus the book should find a very useful place on the shelves of all research mycologists.

G. J. M. A. Gorter.

Johan Graham Anderson.

Bothalia, 10, 3: 405—406

Johan Graham Anderson (1926-1970)

by

B. de Winter

Johan Graham Anderson, Senior Professional Officer in the Botanical Research Institute and, for many years, in charge of the Grass Section, died after a short illness brought on by a coronary thrombosis on 10th March, 1970, at the age of 43 years. Born at Douglas, Cape Province, on 17th October, 1926, he was the son of Hugh Graham Anderson, an Irish medical doctor who settled in South Africa, and Hailie Johanna Anderson (née Steenkamp). When eight years old he contracted poliomyelitis and meningitis simultaneously. Miraculously, he survived but was totally paralysed for a year. After months of constant nursing by his mother, who specially for this purpose took a course in massage, he started regaining the use of his arms, but his legs remained very weak.

In Cape Town he had several operations on his legs and was fitted with calipers, but it was only after his school years that he eventually learnt to walk with crutches. After private tuition as well as several years of regular schooling he passed the matriculation examination. He was then seventeen years of age and his progress must be seen as a remarkable achievement, in view of all the setbacks he had received. During all these years he had the constant help and support of his loving mother and younger brother, Wallace, who stood by him to the end of his life.

Although regarded as being physically unfit for a normal occupation, he was very active mentally and, in 1944, registered at the Potchefstroom University, entering for a B.Sc. course in Botany and Zoology. He left before fully completing the course and, on the 12th of February, 1949, was appointed as Technical Assistant in the then Division of Botany and Plant Pathology. Shortly after this appointment, he registered at the University of South Africa and received his B.Sc. degree in 1951, during which year he was also promoted to Assistant Professional Officer.

On the 14th of January 1956 he married Maria Bezuidenhout and from this marriage four children, two sons and two daughters, were born.

In 1963 he was promoted to Senior Professional Officer. In this rank he served the Botanical Research Institute until his untimely death. From the start of his career at the Institute he was associated with the Grass Section, from the end of 1950 as the officer in charge. The majority of his papers deal with this family, and are listed at the end of this appreciation. During the several years in which he was personally responsible for the general identification of grasses he amassed a deep knowledge of this group, which was to stand him in good stead in his research in later years.

The quality of his work was high and in addition to the listed publications he left a number of important manuscripts (such as the grasses for the revision of the Genera of South African Flowering Plants, the grasses for the Flora of Pretoria and a check-list of the South African grasses) in various stages of completion. His contributions to botany in South Africa should not be seen in

the light of his research output alone. During his career he personally identified more than 25,000 specimens and in addition supplied a wide range of information to numerous fellow botanists as well as scientists in other fields. Few if any of the authors of major works dealing with S.A. grasses — published in recent years — were not to some extent, indebted to Johan Anderson and his assistants at the Botanical Research Institute. Numerous technicians of the Department of Agricultural Technical Services received their basic courses in grass taxonomy as well as training in the identification of grasses from him.

In other spheres he also made significant contributions. He was one of the staff members who worked on the as yet unpublished list of botanical terms compiled jointly by the late Professor A. P. Goossens and the staff of the Botanical Research Institute. He was extremely competent in both official languages and gave invaluable service as a translator of botanical articles. In administrative matters he was meticulous and assisted his seniors by keeping records of various activities of the Institute. For many years he acted as secretary to the regular staff meetings.

It is clear that the constant and usually successful battle against his disabilities and the pain he had to endure deeply influenced his attitude to life. Very few problems seemed to him unsurmountable and he had a cheerful optimism which stimulated all those in contact with him. Perhaps his most outstanding characteristic was his extremely warm and human nature. He drew people to him in a remarkable way, and he was genuinely loved by his colleagues. He had as many friends in the lower ranks as he had among the seniors, thus acting as a link between the young and older staff members. Because of his warmth and inherent fairness he contributed greatly to the friendly atmosphere and the efficiency of the Institute. With his passing many have lost a good friend and colleague.

List of Publications — J. G. Anderson

1959. *Cenchrus brownii*, Burr-grass — Knopklitsgras. *Department of Agriculture Pamphlet.*

1960. Notes and New Records of African Flowering Plants (*Andropogon ravus; Danthonia stereophylla; Panicum volutans*) — *Bothalia* 7: 417-422.

1961. New and Interesting Taxa from Southern Africa (*Andropogon platybasis; Tricholaena monachne* var. *annua; Brachiaria dura* var. *pilosa*) — *Kirkia* 1: 102-104.

1962. Notes and New Records of African Plants (*Andropogon lacunosus*) — *Bothalia* 8: 113-114.

1963. Man and Beast Live on Grass. — Fmg in S. Afr. 39.

1964. Notes and New Records of African Plants (*Eriochrysis brachypogon* subsp. *australis; Danthonia aureocephala*) — *Bothalia* 8: 170-172.

1966. Typhaceae. *Fl. S. Afr.* 1: 53-56.

1966. The genus *Andropogon* in Southern Africa. *Bothalia* 9: 5-30.

1966. A new combination in *Hyparrhenia. Bothalia* 9: 130.

1966. *Common Weeds in South Africa/Algemene Onkruide in Suid-Afrika.* Mem. Bot. Surv. S. Afr. No. 37, 440 pp. (With M. Henderson).

1967. A new species of *Panicum. Bothalia* 9: 341.

1967. A new variety of *Festuca costata. Bothalia* 9: 341.

1967. *Trachypogon spicatus. Flow. Pl. Afr.* 38, t.1512.

Bothalia, 10, 3: 407—410

Cotton Staining caused by Crebrothecium ashbyi (= Eremothecium ashbyi) in South Africa

by

W. F. O. Marasas*

Abstract

A description is given of *Crebrothecium ashbyi* (Guill.) Routien (= *Eremothecium ashbyi* Guill.) which was isolated from yellow stained cotton fibres. This fungus, in association with cotton stainer insects, caused extensive cotton staining in the Vaalharts area of the Cape Province during 1969-1970.

Cotton staining, also known as internal boll rot or stigmatomycosis, is a serious disease which is caused by yeast-like fungi in the genera *Ashbya, Eremothecium, Nematospora* and *Spermophthora* and spread by sucking insects. Although the taxonomy of these fungi has been a source of some controversy (Pridham and Raper, 1950; Lodder and Kreger-Van Rij, 1952), these four genera, characterised by needle-shaped spores, are currently placed in the family Spermophthoraceae of the Endomycetales by most authors (Gäumann, 1964; Von Arx, 1967).

Three species of Spermophthoraceae, *Ashbya gossypii* (Ashby and Nowell) Guill. (= *Nematospora gossypii* Ashby and Nowell), *Nematospora coryli* Pegl. and *Crebothecium ashbyi* (Guill.) Routien (= *Eremothecium ashbyi* Guill.), have been reported as causing cotton staining in association with sucking insects, primarily *Dysdercus* spp. in South Africa (Moore, 1930; Ullyett, 1930; Pearson, 1934, 1947; Wallace, 1939; Wickens, 1940; Rainey, 1948; Pridham and Raper, 1950; Doidge, 1950; Doidge, Bottomley, Van der Plank and Pauer, 1953; Empire Cotton Growers Corporation Progress Reports, 1933-1948; C.M.I. Distribution Maps of Plant Diseases No. 153 and 163). *A. gossypii* is common in the more humid parts of the South African cotton belt while *N. coryli* has been found only occasionally in the northern Transvaal (Moore, 1930; Wickens, 1940). *Crebrothecium ashbyi* has been recorded only once from a single piece of lint at Barberton, Transvaal (Wickens, 1940).

During April 1970, a sample of lemon yellow stained cotton was received from Vaalharts Irrigation Settlement, Cape Province. According to Dr Gillham of the J. L. Clark Cotton Corp., this type of lemon yellow staining had not been observed in the area before and was widespread in the Vaalharts region during the 1969-1970 season although the cotton stainer insect population was low. Microscopic examination of these yellow fibres revealed that they were packed with needle-shaped spores. A lemon yellow, yeast-like fungus, *Crebrothecium ashbyi* (Guill.) Routien, was isolated from these fibres by incubating them on potato dextrose agar at 25°C.

C. ashbyi was first isolated from cotton in the Sudan and described as *Eremothecium ashbyi* Guill. (Guilliermond, 1935; 1936; Tarr, 1955). The new genus *Crebothecium* was erected by Routien (1949) because *E. ashbyi* differs from the type species of *Eremothecium*, *E. cymbalariae* Borzi, in the presence

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of intercalary chains of "asci" and in the indefinite arrangement of spores in the spore sacs.

According to Krneta-Jordi (1962), the only culture of *C. ashbyi* which had previously been isolated is Guilliermond's type strain from the Sudan. The ten isolates of *C. ashbyi* at the Centraalbureau voor Schimmelcultures, Baarn, Netherlands, are apparently all subcultures of the type strain, except possibly CBS 185.6/, B.I.G., which was received from Dr Mach, Bot. Inst. d. Ernst Moritz Arndt Universität, Greifswald, without further particulars (Dr M. A. A. Schipper, personal communication). A culture of *C. ashbyi* which was obtained from the

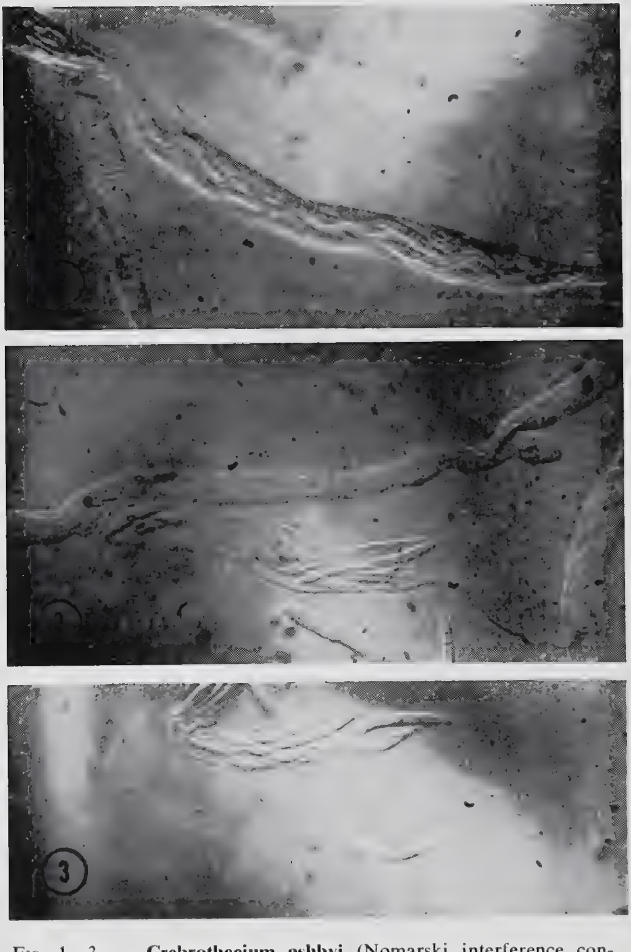

FIG. 1—3. — **Crebrothecium ashbyi** (Nomarski interference contrast, × 1 000). Fig. 1, spore sac filled with spores. Fig. 2, dichotomous branching of hypha and deliquescent spore sac. Fig. 3, spores.

Northern Utilization Research and Development Division, United States Department of Agrculture, Peoria, Illinois, was deposited by A. C. Thaysen without any further information on its source (Dr L. J. Wickerham, personal communication).

Crebrothecium ashbyi (*Guill.*) *Routien* in Mycologia 41: 184 (1949).

Eremothecium ashbyi Guill. in Compt. Rend. Acad. Sci. Paris 200: 1556 (1935); CMI Descriptions of pathogenic Fungi and Bacteria, No. 181 (1968).

Figures: 1, 2, 3.

Colonies grow rapidly on potato dextrose agar and produce spores within 2 days at 25°C. Colonies are Lemon Yellow (Ridgway, 1912, Plate IV), probably due to the production of riboflavin which also diffuses out and stains the agar yellow, flatly appressed, have the appearance of melted snow and produce no aerial mycelium. *Vegetative hyphae* are dichotomously branched, filled with yellow protoplasma, non-septate except in old cultures, 5—7.5μ wide. Usually an entire hypha or a large portion of it becomes fertile, giving rise to chains of intercalary, truncate-ellipsoid spore sacs (asci?). *Spore sacs* are separated by constricted areas in which the hyphal wall is thickened (Callosepfopfen of Krneta-Jordi, 1962), 55—100μ (mostly 70—80μ) long, 7—10μ wide and completely filled with spores (ascospores?). *Spores* are irregularly disposed without any arrangement in fascicles, entangled and overlapping one another, difficult to count but apparently ranging from 8 to 32 (mostly 16) per sac. Spores are released by deliquescence of the spore sac walls, hyaline, non-septate, multiglobulate, needle-shaped, curved and sharply attenuated to a pointed projection at one end, 24—28 x 2—2.5μ (mostly 25 x 2μ).

Assimilation reactions: non-fermentative; glucose, sucrose, trehalose, raffinose, glycerol and succinate are assimilated (kindly determined by Dr. J. P. van der Walt).

Specimen examined: PRE 44335 (Mycological Herbarium), cultures on potato dextrose agar isolated from yellow stained cotton (*Gossypium* sp.) bolls, Vaalharts, Cape Province, April 1970. Cultures have also been deposited in the Centraalbureau voor Schimmelcultures, Baarn, Netherlands (CBS 741.70) and the Northern Utilization Research and Development Division, United States Department of Agriculture, Peoria, Illinois (NRRL Y-7249).

The South African isolate was compared with the following isolates of *C. ashbyi* and found to be identical in all respects: CBS 204.36, *Guilliermond*, Type Culture; NRRL Y-1363, *A. C. Thaysen*. The assimilation reactions of the South African isolate also agree well with the data obtained for NRRL Y-1363 (Dr. L. J. Wickerham, personal communication).

Acknowledgements

The author is grateful to Dr. J. P. van der Walt, Microbiology Research Group, Council for Scientific and Industrial Research, Pretoria, for determining the assimilation reactions and for valuable advice; to Dr. L. J. Wickerham, Northern Utilization Research and Development Division, United States Department of Agriculture, Peoria, Illinois, and Dr. M. A. A. Schipper, Centraalbureau voor Schimmelcultures, Baarn, Netherlands, for cultures and helpful information.

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Bothalia, 10, 3: 411—416

New and Interesting Records of South African Fungi, Part VII

by

W. F. O. Marasas* and G. C. A. van der Westhuizen*

Abstract

Four species of fungi recorded for the first time in South Africa, are described and illustrated. These are: *Acremoniella verrucosa* Togn. from roots of *Medicago sativa; Coniella pulchella* Höhn. from roots of pine-apple; *Periconia igniaria* Mason & Ellis from seed of *Medicago sativa*; and *Stachybotrys subsimplex* Cooke from the cocoon of *Parastizopus armaticeps*.

Four species are described and discussed below. Dried down cultures of all these have been deposited in the mycological collection of the National Herbarium (PRE) at 590 Vermeulen Street, Pretoria.

Acremoniella verrucosa *Togn*., Rend. Inst. Lombardo Sci. Lett., 2 ser., 29: 864 (1896); Horne & Williamson in Ann. Bot. 37: 393 (1923); Horne & Jones in Ann. Bot. 38: 354 (1924); Mason, C.M.I. Mycol. Papers 3: 34 (1933); Groves & Skolko in Can. J. Res. C. 24: 77 (1946).

Eidamia tuberculata Horne & Jones in Ann. Bot. 38: 334 (1924).

Figures: 1, 2.

On corn meal, potato carrot and $1\frac{1}{2}\%$ malt extract agars at 25°C colonies grow rapidly and reach a diameter of 85 mm in 7 days. On potato dextrose agar the growth is slower (25 mm) while no visible growth occurs on Czapek-Dox agar. *Vegetative mycelium* is thinly effused, hyaline and consists of repeatedly branched, septate, hyaline hyphae 5—7.5μ in diameter. Colonies appear brown because of the macroconidia. *Macroconidia* are aleuriospores which are borne singly either on straight to procumbent conidiophores which develop laterally on the main hyphae, or, on conidiophores which proliferate sympodially from a point behind the apex to produce one or more secondary sporogenous cells. *Conidiophores* are hyaline, simple or sparingly branched but the sporogenous cells may branch repeatedly in a sympodial manner to give rise to complex masses, non-septate or up to 8-septate, 10—110μ long, 5—7.5μ in diameter at the base, terminating in sharply tapered sporogenous cells, 2—5μ in diameter at the rounded apex. *Macroconidia* solitary, terminal one-celled, brown, globose, thick-walled, tuberculate, 19—27.5μ in diameter (mostly 22.5μ). *Microconidia* not seen.

Specimen examined: PRE 44334 (Mycological Herbarium), dried culture, isolated from *Medicago sativa* L. roots, Grootrivier, Knysna District, Cape Province, October 1969.

The South African isolate of *A. verrucosa* described here agrees well with the descriptions by Mason (l.c.) and Groves and Skolko (l.c.), except that aspergilliform phialophores and microconidia were not produced by cultures on corn meal agar incubated at 25°C for 4 weeks. This isolate also failed to grow on Czapek-Dox agar in pure culture but grew normally in mixed culture with other fungi such as *Fusarium oxysporum* (Schlecht.) Snyd. et Hans. This confirms

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the findings by Mason (l.c.) and Groves & Skolko (l.c.) that *A. verrucosa* also exhibits the so-called Heald-Pool reaction on Czapek-Dox agar.

This is the first record of the occurrence of this species in South Africa. — W.F.O.M.

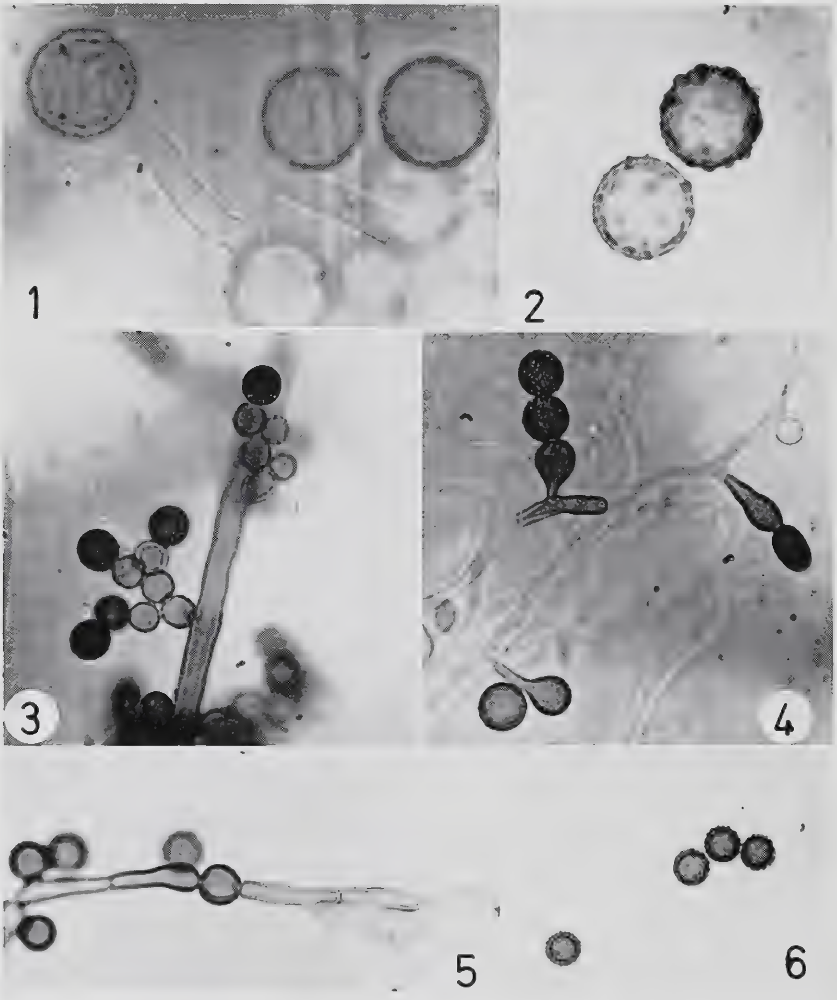

FIG. 1–2. — **Acremoniella verrucosa.** Fig. 1, septate conidiophores bearing terminal macroconidia (× 1,000). Fig. 2, verrucose macroconidia (× 1,000).

FIG. 3—6. — **Periconia igniaria.** Fig. 3, macronematous conidiophore showing branched chains of conidia developing from a sporogenous cell (× 1,000). Fig. 4, micronematous conidiophores (× 1,000). Fig. 5, intercalary spore (× 1,000). Fig. 6, conidia (× 1,000).

Coniella pulchella *Höhnel* in Ber. Dt. Bot. Ges. 36: 316 (1918); Sydow & Petrak in Repert. Nov. Spec. Regn. Veg. Beih. 42: 459 (1927) (repr. 1969); Sutton in Can. J. Bot. 47: 603-608 (1969).

Figures: 7, 8 9.

On potato dextrose agar, mycelium thin, white, floccose or cobwebby, or submerged, covering the plate after 8—1/ days at 25°C. *Pycnidia* scattered, single or gregarious, subglobose to more or less rounded conical, blabrous, seated on a thin white subiculum, 0.05—0.5 mm in diameter, at first hyaline, translucent then darkening with maturation of conidia; pycnidial wall hyaline to sub-hyaline internally, 12—20μ thick and composed of several layers of pseudoparenchymatous cells, ostiolate at maturity. *Conidiophores* hyaline, short, unbranched or branched at the base, tapering apically, arizing from a basal sporodochium-like dome of tissue, 15—20 x 2—3μ, tapering to 1μ in diameter apically. *Conidia* olivaceous-brown, flattened on one side, with a paler, raphe-like longitudinal mark, apex conical or subapiculate and with the base truncate, 8—11 x 5.5—6.5μ.

Specimen examined: PRE 44310, dried down culture, isolated from roots of pine-apple, *Ananas* sp., East London, C.P., February 1968.

The fungus described here has many features in common with *Cyclodomella nigra* Mathur, Bhatt & Thirumalachar (Sydowia 13, 143-147, 1959), a species regarded by Sutton (l.c.) as a synonym of *Coniella diplodiella* (Speg.) Petrak & Sydow (l.c.). The conidia of the specimen described here have their apices conical rather than obtuse, and, because this feature distinguishes *C. pulchella* from *C. diplodiella* (Sutton, l.c.) this fungus is assigned to the former species.

This specimen was isolated from decaying roots of pine-apple plants and was observed in culture only. Although freshly formed conidia were examined even from pycnidia which had not developed to the ostiolate stage, neither the gelatinous "raphe-like structures" nor the "small stalk cell" of the conidia, as described in *Cyclodomella nigra* by Mathur *et al* (l.c.) were ever seen. Also, the pycnidial wall in this isolate remained hyaline with the innermost cells becoming pale olivaceous with age. The mature pycnidia, however, remain essentially hyaline. The dark coloured inner layers reported in pycnidia of *Cyclodomella nigra* by Mathur *et al* (l.c.), were not seen in pycnidia of this isolate. This difference may be of generic importance or may be a variable character. This isolate agrees so well in other respects with the genus *Coniella* Höhnel, however, that it's segregation from that genus does not appear to be justifiable.

This is the first record of this genus in South Africa. — G. C. A. v.d. W.

Periconia igniaria *Mason & M. B. Ellis*, C.M.I. Mycol. Papers 56: 104 (1953); Booth in Brit. Mycol. Soc. Trans. 51: 803 (1968).

Figures: 3, 4, 5, 6.

Considerable variation in cultural appearance occurs on different culture media (Table 1), but colonies are generally woolly and always produce a typical rose-madder or vinaceous pigment. *Vegetative mycelium* is composed of hyaline, thin-walled, smooth or verruculose, branched, septate hyphae approximately 3μ in diameter. At the base of macronematous conidiophores the hyphae are swollen, brownish and very coarsely warted or encrusted. *Conidia* (blastospores) are borne on micronematous and macronematous conidiophores but on some media only micronematously (Table 1). *Micronematous conidiophores* are formed by enlargement of the vegetative hyphal cells to become cylindrical, brown, thick-walled, smooth or verruculose sporogenous cells, 9—20 x 4—6μ. The sporogenous cells give rise to straight or branched chains of conidia which developed in acropetal succession but mature basipetally (Fig. 4). The cells of

micronematous conidiophores apparently also have the ability to round off and form intercalary chlamydospores which are morphologically indistinguisable from the blastospores (Fig. 5). *Macronematous conidiophores* arise singly, in small groups or in dense clusters on the vegetative mycelium (Fig. 3). Stipes are erect, stout, unbranched, brown, smooth or verruculose, 4—8-septate, 225—540μ long, 5—7.5μ in diameter at the base and 5μ in diameter at the obtuse apex. The cells of macronematous conidiophores give rise to conidia directly or to distinguishable sporogenous cells which are light brown, ovoid, smooth or verruculose, 8—10 x 6—7μ (Fig. 3). Branching chains of conidia which form loose heads are borne apically and laterally on the stipes. *Conidia* are blastospores which develop acropetally but mature basipetally, spherical, dark-brown, one-celled, 7—11 (mostly 8μ) in diameter, thick-walled, spinose with spines approximately 1μ long (Fig. 6).

Specimen examined: PRE 43738 (Mycological Herbarium), dried culture, isolated from *Medicago sativa* L. seed, Upington, Cape Province, July 1969.

The isolate from *Medicago sativa* seed described here agrees very well with the description by Mason & Ellis (*l.c.*). No reference could be found in the literature to the apparent "intercalary chlamydospores" frequently observed in our culture. These structures may develop in two different ways: (1) A cell of the micronematous conidiophore rounds up to form an intercalary chlamydospore. (2) A sporogenous cell of the micronematous conidiophore gives rise to

TABLE 1. — Cultural characteristics of *Periconia igniaria*[a]

Culture media[b]	Growth rate (mm/day)	Sporulation (21 days)	Colony colour after 21 days: Surface	Colony colour after 21 days: Reverse
CMA	3.9	Micro- and Macronematous	Centre Rose-madder Margin Buff	Brown tinged with Rose-madder
OMA	4.6	Micro- and Macronematous	Centre Rose-madder Margin Buff	Greenish-grey tinged with Rose-madder
1½ MA	4.8	Micro- and Macronematous	Centre Smoky-grey Margin white tinged with Rose-madder	Brown tinged with Rose-madder
PCA	4.7	Micronematous	Centre Rose-madder Margin white	White tinged with Rose-madder
PDA	4.7	None	Centre Smoky-grey Margin white tinged with Rose-madder	Brown tinged with Rose-madder

[a] Based on five single spore isolates of PRE 43738 on each of five culture media incubated at 25°C for 21 days.

[b] CMA = corn meal agar.
OMA = Oat meal agar.
1½ MA = 1½% Malt extract agar.
PCA = Potato carrot agar.
PDA = Potato dextrose agar.

a blastospore which in turn gives rise to another sporogenous cell in stead of a successive blastospore with the result that the blastospore appears to be an intercalary chlamydospore. Somewhat analogous heavy-walled cells giving rise to a further conidiophore have been described in *Acremoniella velata* by Onions & Jones (Brit. Mycol. Soc. Trans. 51: 151-152, 1968). They referred to these cells as "rudimentary conidia". This question will have to be resolved by a developmental study in slide culture to determine the exact method of formation of these spores.

Booth (*l.c.*) described the perithecial state of *P. igniaria* as *Didymosphaeria igniaria*. He reported that the species is homothallic and that uniloculate ascostromata are produced when cultures are grown on potato dextrose agar with pieces of wheat straw and subjected to near ultraviolet light.

Mason & Ellis (*l.c.*) found *P. igniaria* on plants which have been scorched or prematurely killed by burning. They recorded this species on eight different host plants in England and on *Borassus flabellifer* var. *aethiopica* in Ghana. *P. igniaria* has also been isolated from soil by Stenton at Wicken Fen, Cambridgeshire (Mason & Ellis, *l.c.*) and from the surface layer of a sand dune at Sandwich, Kent by Brown (J. Ecol. 46: 641-664, 1958). The South African isolate was obtained from lucerne seed surface sterilized with Nance solution (1 g $HgCl_2$, 10 ml 0.1N HCl, 12 ml Teepol, diluted to 1 litre) for 90 seconds, washed five times with distilled water and plated on potato dextrose agar. One hundred seeds were treated in this way and only two yielded fungal colonies, both of which proved to be *P. igniaria*. These findings suggest that the spores of *P. igniaria* are very resistant to heat and chemical treatment, probably because of the thick epispore.

This is a new host record for *P. igniaria*, the first record of the occurrence of this species on seed and the first record of the occurrence of this species in South. Africa. — W.F.O.M.

Stachybotrys subsimplex *Cooke* in Grevillea 12:33 (1883); Bisby in Trans. Brit. Mycol. Soc. 26: 133-143 (1943).

Figures: 10, 11, 12.

Colonies on potato-malt-filter paper agar, slow growing, reaching a diameter of 30 mm in two weeks, black, woolly-funiculose with trailing ropes of hyphae bearing conidiophores which terminate in black, glistening, slimy spore masses. *Hyphae* hyaline at first becoming fuliginous, branching, septate, 2—4μ in diameter. *Conidiophores* arizing from funicles of aerial hyphae, hyaline at first later fuliginous to dark olivaceous brown in age, simple or occasionally branched, tapering gradually from the base to the tip, smooth or finely roughened, 0—3 septate and bearing a whorl of 3—7 sporogenous cells terminally, 30—55 x 2.5—5.0μ. *Sporogenous cells* hyaline at first, later fuliginous oblong-ovoid often somewhat flattened on one side and curving, 7.0—12.0 x 3.0—5.0μ. *Conidia* dark olivaceous, thick-walled, finely verrucose, subglobose 5.0—7.0μ in diameter or ellipsoidal and somewhat pointed, 5.5—7.0 x 5.0—6.0μ, borne in globules of slime.

Specimen examined: PRE 44311 (Mycological Herbarium) on potato-malt-filter paper agar, isolated from cocoon of *Parastizopus armaticeps*, Twee Rivieren, Kalahari Gemsbok Park, May 1969.

The fungus described here agrees very well with the description of this species in culture by Bisby (*l.c.*). He thought that this species is a saprophyte of the warmer regions and that the genera *Gliobotrys* Höhnel and *Memnoniella* Höhnel are based on this species. In the South African isolate it was noticed that the young conidia were somewhat ellipsoidal smooth-walled and pale coloured

but that older conidia are sub-globose, dark and roughened. The conidia were always produced in slime balls, however. No chains of conidia which may suggest a "*Memnoniella* stage" were ever seen in this isolate.

This is the first record of this species in South Africa. — G.C.A. v.d. W.

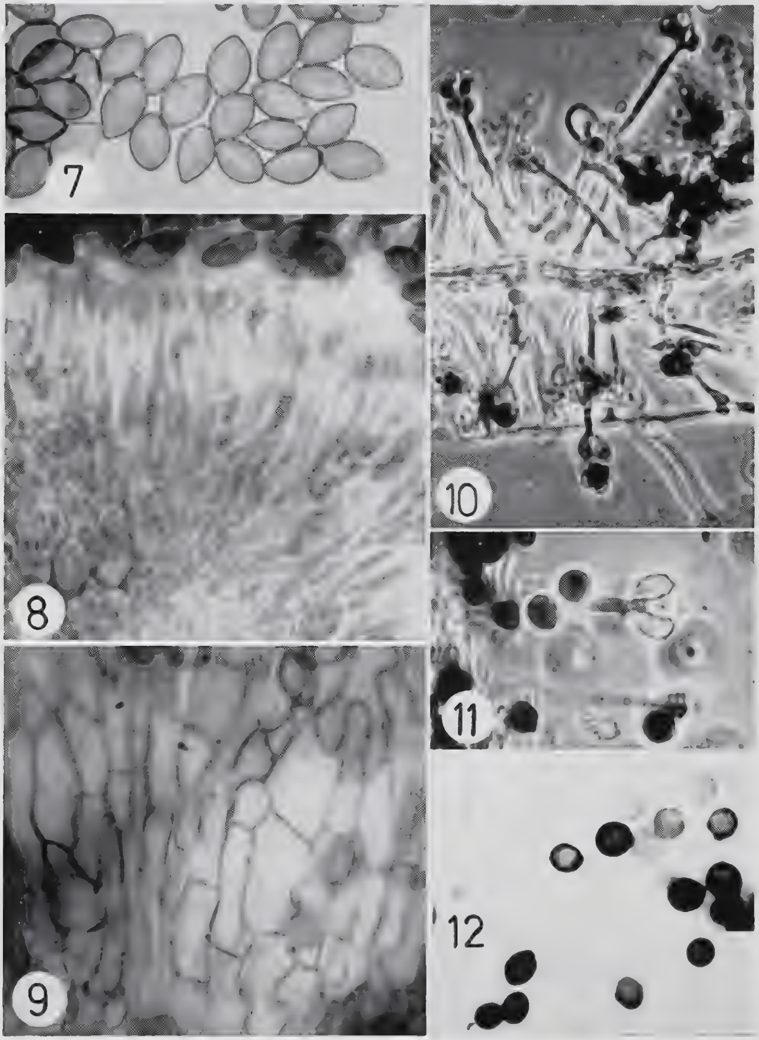

FIG. 7—9. — **Coniella pulchella.** Fig. 7, conidia (× 1,000). Fig. 8, conidiophores with young conidia and part of sporodochium-like dome (× 1,000). Fig. 9, part of pycnidium wall (× 1.000).

FIG. 10—12. — **Stachybotrys subsimplex.** Fig 10, conidiophores arising from hyphal strand (× 400 phase contrast). Fig. 11, sporogenous cells on conidiophores (× 1,000 phase contrast). Fig. 12, conidia at various stages of maturity (× 1,000).

Bothalia, 10. 3: 417—418

New Combinations in the Genera Brettanomyces, Kluyveromyces, Lodderomyces and Wingea

by

J. P. van der Walt*

Van der Walt and Van Kerken (1959) and Van der Walt (1965, 1966, 1967) introduced several non-valid combinations in the genera *Brettanomyces, Kluyveromyces, Lodderomyces* and *Wingea* by omitting to list relevant basionyms according to the requirements of Article 33 of the International Code of Botanical Nomenclature. As these combinations, however, have been adopted in the new taxonomic treatise edited by Lodder (1970), they are now validated in conformance with the requirements of the Code.

Brettanomyces intermedius *(Krumbholz & Tauschanoff) v.d. Walt & v. Kerken,* comb. nov.

Basionym: *Mycotorula intermedia* Krumbholz & Tauschanoff in Zentr. Bakteriol. Parasitenkunde Abt. II, 88: 367 (1933).

Kluyveromyces aestuarii *(Fell) v.d. Walt,* comb. nov.

Basionym: *Saccharomyces aestuarii* Fell in Antonie van Leeuwenhoek 27: 29 (1961).

Kluyveromyces bulgaricus *(Santa Maria) v.d. Walt,* comb. et stat. nov.

Basionym: *Saccharomyces fragilis* Jörgensen var. *bulgaricus* Santa Maria in Anales Inst. Nac. Invest. Agric. 8: 165 (1956).

Kluyveromyces delphensis *(v.d. Walt & Tscheuschner) v.d. Walt,* comb. nov.

Basionym: *Saccharomyces delphensis* v.d. Walt & Tscheuschner in Antonie van Leeuwenhoek 22: 165 (1956).

Kluyveromyces dobzhanskii *(Shehata, Phaff & Mrak) v.d. Walt,* comb. nov.

Basionym: *Saccharomyces dobzhanskii* Shehata, Phaff & Mrak in Mycologia 47: 805 (1955).

Kluyveromyces drosophilarum *(Shehata, Phaff & Mrak) v.d. Walt,* comb. nov.

Basionym: *Saccharomyces drosophilarum* Shehata, Phaff & Mrak in Mycologia 47: 804 (1955).

Kluyveromyces fragilis *(Jörgensen) v.d. Walt,* comb. nov.

Basionym: *Saccharomyces fragilis* Jörgensen in Die Mikro-organismen der Gärungsindustrie 5te Auflage, Berlin, p. 377 (1909).

Kluyveromyces lactis *(Dombrowski) v.d. Walt,* comb. nov.

Basionym: *Saccharomyces lactis* Dombrowski in Zentr. Bakteriol. Parasitenkunde Abt. II, 28: 366 (1910).

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Kluyveromyces lodderi *(v.d. Walt & Tscheuschner) v.d. Walt,* comb nov.
Basionym: *Saccharomyces lodderi* v.d. Walt & Tscheuschner in Antonie van Leeuwenhoek 23: 188 (1957).

Kluyveromyces marxianus *(Hansen) v.d. Walt,* comb. nov.
Basionym: *Saccharomyces marxianus* Hansen in Meddelelser Carlsberg Laboratoriet 2: 222, 1883-88 (1888).

Kluyveromyces phaffii *(v.d. Walt) v.d. Walt,* comb. nov.
Basionym: *Fabospora phaffii* v.d. Walt in Antonie van Leeuwenhoek 29: 320 (1963).

Kluyveromyces phaseolosporus *(Shehata, Phaff & Mrak) v.d. Walt,* comb. nov.
Basionym: *Saccharomyces phaseolosporus* Shehata, Phaff & Mrak in Mycologia 47: 806 (1955).

Kluyveromyces vanudenii *(v.d. Walt & Nel) v.d. Walt,* comb. nov.
Basionym: *Saccharomyces vanudenii* v.d. Walt & Nel in Mycopathol. Mycol. Appl. 20: 73 (1963).

Kluyveromyces veronae *(Lodder & Kreger-v. Rij) v.d. Walt,* comb. nov.
Basionym: *Saccharomyces veronae* Lodder & Kreger-v. Rij in The Yeasts, 1st Edition, Amsterdam, p. 669 (1952).

Kluyveromyces wickerhamii *(Phaff, Miller & Shifrine) v.d. Walt,* comb. nov.
Basionym: *Saccharomyces wickerhamii* Phaff, Miller & Shifrine in Antonie van Leeuwenhoek 22: 150 (1956).

Lodderomyces elongisporus *(Recca & Mrak) v.d. Walt,* comb. nov.
Basionym: *Saccharomyces elongisporus* Recca & Mrak in Food Technology 6: 451 (1952).

Wingea robertsii *(v.d. Walt) v.d. Walt,* comb. nov.
Basionym: *Pichia robertsii* v.d. Walt in Antonie van Leeuwenhoek 25: 342 (1959).

Saccharomyces kloeckerianus *v.d. Walt,* nom. nov.
Synonym: *Debaryomyces globosus* Klöcker in Compt. rend. trav. lab. Carlsberg 7: 273, 1907-'09 (1909).

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Van der walt, J. P., 1966. Lodderomyces, a new genus of Saccharomycetaceae. *Antonie van Leeuwenhoek* 32: 1-5.

Van der Walt, J. P., 1967. Wingea, a new genus of Saccharomycetaceae. *Antonie van Leeuwenhoek* 33: 97-99.

Van der Walt, J. P. & Van Kerken, A. E., 1959. The wine yeasts of the Cape. Part V. The occurrence of *Brettanomyces intermedius* and *Brettanomyces schanderlii* in South African table wines. *Antonie van Leeuwenhoek* 25: 145-151.

Bothalia, 10, 3: 419—426

Acacia brevispica and A. schweinfurthii

by

J. H. Ross*

Abstract

Recently Brenan, in Kew Bull. 21 : 477-480 (1968), upheld *Acacia brevispica* Harms and *A. schweinfurthii* Brenan & Exell as distinct species and recognized two subspecies within *A. brevispica.* These conclusions differ from earlier results published by Ross & Gordon-Gray in Brittonia 18: 44-63 (1966). Consequently it was considered necessary to re-examine these species in preparation for the account of *Acacia* for the Flora of Southern Africa. Distribution maps of the two species are provided and the differences between the species tabulated and discussed. Despite certain difficulties in Natal, Brenan's taxonomic conclusions are adopted. A map showing the distribution of *A. schweinfurthii* and *A. brevispica* subsp. *dregeana* in Natal is provided and a selection of Natal specimens cited.

Recently Brenan, in Kew Bull. 21 (3): 477-480 (1968), discussed *Acacia brevispica* Harms and *A. schweinfurthii* Brenan & Exell in preparation for his account of the Mimosoïdeae for Flora Zambesiaca. Brenan's taxonomic conclusions are, briefly, that *A. brevispica* and *A. schweinfurthii* are specifically distinct, and that two subspecies are recognizable within *A. brevispica* namely:

(a) subsp. *brevispica;*

(b) subsp. *dregeana* (Benth.) Brenan.

The two varieties within *A. schweinfurthii* namely var. *schweinfurthii* and var. *sericea* recognized by Brenan and Exell in Bol. Soc. Brot. sér. 2, 31: 114-5 (1957) were upheld.

Brenan's conclusions differ from those reached by Ross and Gordon-Gray in Brittonia 18: 44-63 (1966) after a study of these two species, with particular reference to Natal. The taxonomic conclusions reached by Ross and Gordon-Gray were, briefly, that *A. brevispica* and *A. schweinfurthii* are not specifically distinct and that three varieties are recognizable within *A. brevispica,* namely:

(a) var. *brevispica;*

(b) var. *dregeana* (Benth.) Ross & Gordon-Gray;

(c) var. *schweinfurthii* (Brenan & Exell) Ross & Gordon-Gray.

The two varieties within *A. schweinfurthii* (in Brenan and Exell's sense) namely, var. *schweinfurthii* and var. *sericea* were not upheld.

Therefore, whilst there is general agreement that three main entities are present, namely, *brevispica, dregeana* and *schweinfurthii* there is disagreement about the taxonomic status of each entity. I have also had to come to a decision for the account of the Mimosoïdeae that is being prepared for the Flora of Southern Africa. It seems therefore necessary to examine the cause of this disagreement. I have been fortunate in having had the opportunity of discussing this matter at some length with Mr. J. P. M. Brenan whilst visiting Kew some years ago.

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The distribution of *A. brevispica* subsp. *brevispica* (the three entities are referred to in accordance with Brenan's conclusions) and of *A. brevispica* subsp. *dregeana* may be seen in Fig. 1, whilst that of *A. schweinfurthii* is given in Fig. 2. *A. brevispica* subsp. *brevispica* occurs in tropical north-east Africa to as far south as central Tanzania and then again in Angola. Subsp. *dregeana* occurs in southern Mozambique, Natal and Pondoland. There is therefore a large geographical discontinuity between the populations of subsp. *brevispica* in central Tanzania and those in Angola. In addition there is a large discontinuity between the populations of subsp. *brevispica* in these two territories and the populations of subsp. *dregeana* in southern Africa. *A. schweinfurthii* occurs in north-east tropical Africa and extends southwards to Mozambique, the Transvaal and Natal. The species is not recorded from Kenya nor Uganda.

FIG. 1. — The known distribution of **A. brevispica** subsp. **brevispica** and **A. brevispica** subsp. **dregeana** in Africa based upon an examination of herbarium specimens and on information supplied by Brenan & Exell in Bol. Soc. Brot., sér. 2, 31: 99-140 (1957).

FIG. 2. — The known distribution of **A. schweinfurthii** in Africa based upon an examination of herbarium specimens and on information supplied by Brenan & Exell (l.c.) 1957.

A. brevispica and *A. schweinfurthii* form part of a complex of very closely related species (see Brenan & Exell in Bol. Soc. Brot., sér. 2: 99-140, 1957, and Brenan, Fl. Trop. E. Afr. Legum. — Mimos., 1959). In tropical Africa, *brevispica* and *schweinfurthii* are readily distinguishable on the basis of petiole length: in *brevispica* petiole length varies from 0.4—1.3 (—1.5) cm and in *schweinfurthii* from 2.6—3 (—5.5) cm. No difficulty is experienced in referring specimens either to one species or to the other on the basis of petiole length *alone*. However, petiole length in *dregeana* is exceedingly variable, even on a single plant, and ranges from 1—3.5 cm. In southern Mozambique and in Natal, where *dregeana* and *schweinfurthii* both occur, no distinction can be drawn between these two entities on the basis of petiole length.

Similarly rachis length, rachilla length, leaflet length, leaflet width, leaflet spacing, pod length and pod width reflect no discontinuity between *dregeana* and *schweinfurthii* in southern Mozambique and in Natal (see Ross & Gordon-Gray *l.c.*). It is in this area, particularly in Natal, that difficulty is sometimes encountered when attempting to distinguish specimens of *dregeana* and *schweinfurthii*. This difficulty is not experienced in tropical Africa as *dregeana* does not occur there and the difficulty scarcely makes itself felt in southern Mozambique.

There are differences between *dregeana* and *schweinfurthii* and there is general agreement on the characters by which the two entities may be differentiated. The problem essentially is how much significance is to be placed on these differences in reaching a decision concerning the taxonomic status of these two entities. What then are the differences between *dregeana* and *schweinfurthii*?

TABLE 1. — Synopsis of the differences between *brevispica*, *dregeana* and *schweinfurthii*.

brevispica	*dregeana*	*schweinfurthii*
Young branchlets grey-brown	Young branchlets grey-brown	Young branchlets olive-green to olive-brown
Indumentum on young branchlets and rachides spreading and exceeding the glands	Indumentum on young branchlets and rachides shortly appressed-pubescent, pubescence shorter than the glands	Young branchlets puberulous when young
Petiole 0.4—1.5 cm long	Petiole 0.5—3.5 cm long	Petiole 2.6—5.5 cm long
Petiolar gland 1.5—3.0 mm long, sometimes absent	Petiolar gland 0.5—1.5 mm long, sometimes absent	Petiolar gland humped, 1—1.8 mm long, sometimes 2 glands present or gland absent
Leaflets 0.5—1.25 mm wide; with conspicuous whitish often spreading marginal cilia, glabrous abaxially apart from the cilia	Leaflets 0.6—1.2 mm wide; usually with short inconspicious marginal cilia, abaxial surface usually densely appressed-pubescent, sometimes only portion of the leaflet sparingly appressed-pubescent or occasionally entire leaflet glabrous	Leaflets 0.8—2 mm wide; with conspicuous whitish appressed marginal cilia, invariably glabrous abaxially apart from the cilia (very few specimens with appressed-pubescence are referrable to var. *sericea*)
Pods puberulous, glandular	Pods puberulous, glandular	Pods glabrous or almost so, glandular

Ross & Gordon-Gray (*l.c.*: 59) stated that: "The only observed differences (between *dregeana* and *schweinfurthii*) are in leaflet and pod pubescence, number, position, and to some extent, shape of petiolar glands and colouration of young twigs". Brenan in Kew Bull. 21: 479 (1968) uses these same characters to distinguish *dregeana* and *schweinfurthii*. Re-examination of all available specimens has not revealed any additional useful characters (see Table 1).

Brenan in Kew Bull. 21: 479 (1968) enumerates in some detail the differences between *brevispica* and *dregeana*. These two entities are quite readily distinguished and it is unlikely that any difficulty will be experienced in referring specimens to either entity, particularly in view of the large geographical discontinuity between the two.

Whilst working on *dregeana* and *schweinfurthii* in Natal prior to the publication of the paper in Brittonia, it was felt that *dregeana* bridged the gap between *brevispica* and *schweinfurthii* in respect of petiole, rachis and rachilla length, leaflet length and width, leaflet spacing, pod length and width, and that the characters enumerated in Table 1 were not sufficiently distinctive to enable *brevispica* and *schweinfurthii* to be maintained as distinct species. Brenan (Kew Bull. 21: 479, 1968) contends that "this wide range of petiole-length (and presumably the other characters) is *characteristic of dregeana*, and that *dregeana* is a taxon more distinct from typical *A. brevispica* and *A. schweinfurthii* than implied by Ross & Gordon-Gray . . . ". Brenan (*l.c.*) continued "a case may be made out for considering *dregeana* as a species distinct both from *A. schweinfurthii* and *A. brevispica*, but this does not seem to be really justified since, in general appearance and characters, *dregeana* is so very close to *A. brevispica*". Little would be achieved by giving *dregeana* specific status since the problem of satisfactorily differentiating *dregeana* and *schweinfurthii* remains irrespective of the taxonomic rank held by *dregeana*.

The distinguishing criteria between *dregeana* and *schweinfurthii* are essentially differences in the colour of the young branchlets, differences in the degree of pubescence of the young branchlets, leaflets and pods and, to a lesser extent, in leaflet size. Differences in the degree of pubescence are often difficult to evaluate. For example, it may be difficult to establish whether a young branchlet is puberulous or whether it is shortly appressed-pubescent. Although all of the above characters must be used in conjunction, the pubescence of the lower leaflet surface seems to offer the most promising character in distinguishing *dregeana* from *schweinfurthii*. In *schweinfurthii* the leaflets are invariably glabrous abaxially apart from the appressed marginal cilia. Very few specimens with appressed-pubescence on the abaxial leaflet surface (referred to var. *sericea* Brenan & Exell) have been recorded throughout the species range. In *dregeana* the abaxial leaflet surfaces are either densely appressed-pubescent throughout or else the pubescence is confined to a portion of the surface. Sometimes, and particularly in the middle reaches of the Tugela River, for example *Ross* 184 (NU) from near Keats Drift, and on the Lebombo mountains in Zululand, for example *Ross* 305, 1175 (NH, NU), the leaflets are entirely glabrous or have only a few inconspicuous marginal cilia. Specimens of var. *sericea* with their appressed-pubescent abaxial leaflet surfaces may prove difficult to distinguish from *dregeana* on this character but identification should be possible by using the other characters.

On the basis of the characters enumerated in Table 1 most specimens from southern Mozambique and from Natal can be fairly readily sorted. However, some specimens do create difficulties and it is sometimes debatable whether they are robust specimens of *dregeana* or depauperate specimens of *schweinfurthii*.

One specimen in particular, namely *Ross* 874 (NU) from just south of Mandini near the Tugela river, is difficult to place with certainty. The specimen, which was growing in a thicket of *schweinfurthii*, has densely appressed-pubescent abaxial leaflet surfaces and densely puberulous, glandular pods similar to those of *dregeana*. In general facies the specimen resembles *schweinfurthii* and although not typical of *schweinfurthii* is probably best placed in *schweinfurthii*.

In deciding to sink *A. schweinfurthii* under *A. brevispica* (Ross & Gordon-Gray, *l.c.*) a certain amount of reliance was placed on Brenan and Exell's comment (*l.c.*: 115) that three specimens from central and southern Tanzania (two of which were examined) "are perhaps crosses between *A. brevispica* and *A. schweinfurthii*, having longer petioles and rather smaller heads than the former and narrower leaflets than the latter". It was felt that these specimens pointed to the occurrence of intermediates in east Africa similar to the situation prevailing in Natal. Now Brenan in Kew Bull., *l.c.*: 478 has stated: "The three possible hybrids mentioned by Brenan & Exell in Bol. Soc. Brot., sér. 2, 31: 115 (1957) are very dubious. Two of them, from Lindi District in Tanzania, are outside the range of typical *A. brevispica* and are more likely to be poor specimens of *A. taylorii* Brenan & Exell, at that time imperfectly known". Whilst these specimens may well be *A. taylorii* this prevailing uncertainty does nevertheless illustrate how difficult it is to identify some of the species within this complex with certainty. Examination of specimens and of the keys to the identification of the species within this complex provided by Brenan & Exell (*l.c.*) and by Brenan (*l.c.*, 1959) reveals how closely related many of the species are and on what slender grounds some of the species are recognized.

A decision concerning the taxonomic status of *dregeana* and *schweinfurthii* must be seen against the background of all the African species within this complex. For almost its entire range of distribution *schweinfurthii* is an easily recognizable species. It is only near its southern limit of distribution in Natal that *schweinfurthii* is sometimes confused with *dregeana*. Natal, a small province comprising only 8% of the area of the Republic of South Africa, forms a very small part of the distributional range of *schweinfurthii*. The occurrence of the characteristically variable *dregeana* at the southern limit of distribution of this complex of species need not therefore prevent *brevispica* and *schweinfurthii* from being maintained as distinct species, even although they are very closely related. Consequently I am prepared, albeit somewhat hesitantly, to follow Brenan's decision to regard *dregeana* and *schweinfurthii* as belonging to different species even although the differences between them are at times rather ill-defined, and although difficulties will sometimes be experienced when attempting to identify specimens. With *A. brevispica* and *A. schweinfurthii* now established as distinct species subspecific status is the correct taxonomic rank for *dregeana* within *A. brevispica*.

The distribution of *A. schweinfurthii* and of *A. brevispica* subsp. *dregeana* in Natal is seen in Fig. 3. *A. schweinfurthii* is typically coastal in distribution and plants usually grow on the margin of riverine forest or in riverine fringing vegetation. *A. brevispica* subsp. *dregeana* is found more commonly in the interior and plants thrive in dry thornveld and in the dry scrub of the interior river valleys. There is apparently a fairly large geographical discontinuity between the population in the Umkomaas valley near Richmond and the plants in Pondoland, the latter being the type locality of subsp. *dregeana*.

As a consequence of its preference for moister situations, plants of *A. schweinfurthii* appear more robust and verdant in the field. The flowers of *A. schweinfurthii* are frequently in larger and more open terminal panicles than in the

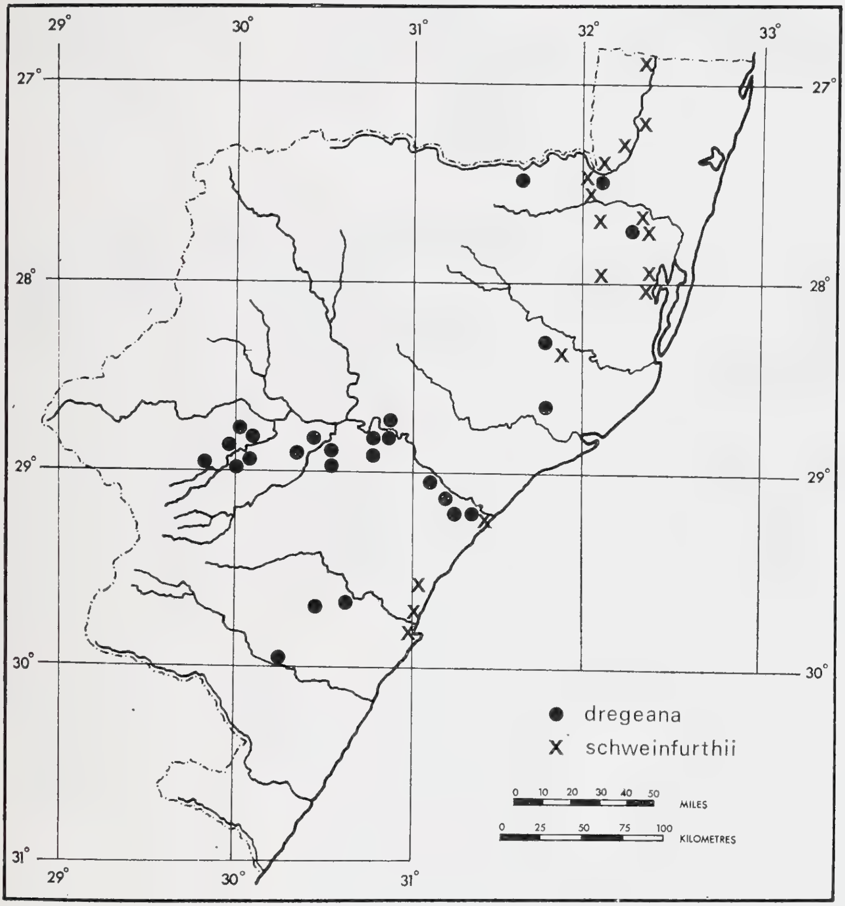

FIG. 3. — The known distribution of **A. brevispica** subsp. **dregeana** and **A. schweinfurthii** in Natal based upon field studies and an examination of herbarium specimens.

case of *A. brevispica* subsp. *dregeana*. The pods of *A. brevispica* subsp. *dregeana* dehisce quite readily whilst those of *A. schweinfurthii* are usually only tardily dehiscent or at times apparently indehiscent.

In view of the past confusion within this complex in Natal the opportunity is taken of citing a selection of the Natal material.

A. brevispica *Harms* subsp. **dregeana** *(Benth.) Brenan*

NATAL. — 2731 (Louwsburg): 1 km from Pongola bridge on Magudu road (—BC), *Edwards* 3187 (NU, PRE). 2732 (Ubombo): Ingwavuma (—AA), *Moll & Strey 4021* (NH); Majozini, approx. 5 km S. of Pongola Poort (—AC), *Ward 3917* (NH, NU); Mkuze Game Reserve (—CB), *Ward 3504* (NH, NU). 2830 (Dundee): Mngwenya valley, river crossing on Weenen-Middelrest road (—CC), *Edwards 2811* (NU); Muden (—CD), *Sim 19082* (NU);

24 km from Greytown on Keats Drift road (—DC), *Ross 184* (K, NH, NU); Jamesons Drift (—DD), *Ross 834* (NH, NU). 2831 (Nkandla): Umfolozi Game Reserve, bank of White Umfolozi river (—BC), *Ross 2029* (NH, PRE). 2929 (Underberg): Estcourt Pasture Research Station (—BB). *Acocks 9893* (NH). 2930 (Pietermaritzburg): Ashburton (—CB), *Ross 443* (K, NH, NU); 16 km from Richmond on Ixopo road, Umkomaas valley (—CD). *Ross 116* (NH, NU); 2.5 km S.E. of pumping station on Nagle Dam road, Umgeni valley (—DA), *Ross 246* (K, NH, NU). 2931 (Stanger): opposite Nembe river confluence, Lower Tugela valley (—AB), *Edwards 3045* (NH, PRE).

A. **schweinfurthii** *Brenan & Exell* var. **schweinfurthii**

NATAL. — 2632 (Bela Vista): Ndumu Game Reserve, near Banzi Pan (—AB), *Ross 697* (K, NH, NU). 2732 (Ubombo): Mkuze bridge, 3 km N. of Mkuze on Candover road (—CA), *Ross 1022* (K. NH, NU); Mkuze Game Reserve, Fig Park (—CB), *Ross 310* (K, NH. NU); False Bay Park (—CD), *Ross 2326* (NH, PRE). 2831 (Nkandla): Umfolozi Game Reserve, Matshamshlope (—BD), *Downing 561* (NH, NU); Heatonville (—DB), *De Waal 39203* in NH. 2832 (Mtubatuba): Hluhluwe Game Reserve (—AA), *Ward 1835* (NH, NU). 2931 (Stanger): 45 km from Kranskop on Mapumulo valley road (—AA), *Moll 924* (NU); 3 km S. of Mandini on old main road (—AB), *Ross 872* (NH, NU); Verulam (—CA), *Ross 167* (K, NH, NU); 1.5 km N. of Virginia Airport (—CC), *Ross 484* (NU).

Bothalia, 10, 3: 427—430

A Variant of Acacia karroo from Sekukuniland

by

J. H. Ross*

Abstract

The relationship of some densely pubescent specimens from Sekukuniland in the eastern Transvaal to *Acacia gerrardii* Benth. and to *A. karroo* Hayne is discussed. The specimens were found to represent part of the range of variation of *A. karroo*. A map showing the known distribution of the densely pubescent plants is provided.

Nearly twenty years ago specimens of a most interesting *Acacia* were collected by Dr. L. E. Codd near Steelpoort in the Lydenburg district of the Transvaal. A few specimens have been collected subsequently and these have all lain unnamed in the National Herbarium, Pretoria.

Initially these specimens were thought to represent a new species somewhat intermediate in position between *A. karroo* Hayne and *A. gerrardii* Benth. The densely pubescent young branchlets, leaves, leaflets and pods are similar to those of *A. gerrardii* whilst the bright yellow flowers with reflexed corolla lobes resemble those of *A. karroo*. However, a closer examination of the specimens suggested that the relationship to *A. gerrardii* is superficial and that the true relationship is with *A. karroo*. This suggestion was subsequently strengthened by field observations.

A. karroo, which is an extremely widespread and variable species, typically has glabrous young branchlets, leaf petioles, rachides, rachillae, leaflets, peduncles and pods. However, specimens are found with sparingly pubescent young branchlets, petioles, rachides, rachillae, leaflets and peduncles. These specimens from Steelpoort differ from "typical" *A. karroo* in the dense development of the indumentum on these organs, particularly the conspicuous spreading marginal cilia on the leaflets and the densely pubescent, glandular pods.

Although superficially resembling *A. gerrardii*, the specimens have bright yellow flowers in contrast to the white flowers in *A. gerrardii*. In *A. gerrardii* the flowers are in fascicles on axillary peduncles along the branchlets, often on the previous season's growth whereas in these specimens the fascicled axillary peduncles tend to form a terminal raceme or sometimes the flowers occur on lateral axillary branchlets, the entire inflorescence forming an irregular terminal panicle. The specimens differ vegetatively from *A. gerrardii* in that they lack the large cushion-like abbreviated shoots between each pair of spines from which the leaves arise. These "cushions" persist on older branches of *A. gerrardii* and provide a very useful means of identification. Although the pods of these specimens resemble those of *A. gerrardii* the seeds are elliptic and not $\pm$ quadrate as in *A. gerrardii*. Similarly areole shape also differs. These specimens differ therefore quite significantly from *A. gerrardii* and are readily distinguished from that species. Specimens of this *Acacia* and *A. gerrardii* were observed growing together near the Mapochs River in Sekukuniland and both were readily distinguishable.

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Last year Mr. J. W. Morris, to whom I am very grateful, collected an excellent set of specimens in the vicinity of Roossenekal (see Fig. 1). Although these specimens had densely pubescent young branchlets, leaves and pods they nevertheless differed somewhat from the Steelpoort specimens and had a distinct "*A. karroo* look" about them. The Roossenekal specimens had larger leaves, more pinna pairs and, in some instances, a much sparser development of the indumentum than the Steelpoort specimens.

In the field in Sekukuniland from a distance of a few metres the densely pubescent plants of this *Acacia* (hereafter referred to as *Acacia*) are indistinguishable from plants of *A. karroo*. It is only on approaching the plants and on seeing the indumentum on the young branchlets, leaves and pods that it is possible to establish with certainty that the plants differ from "typical" *A. karroo*.

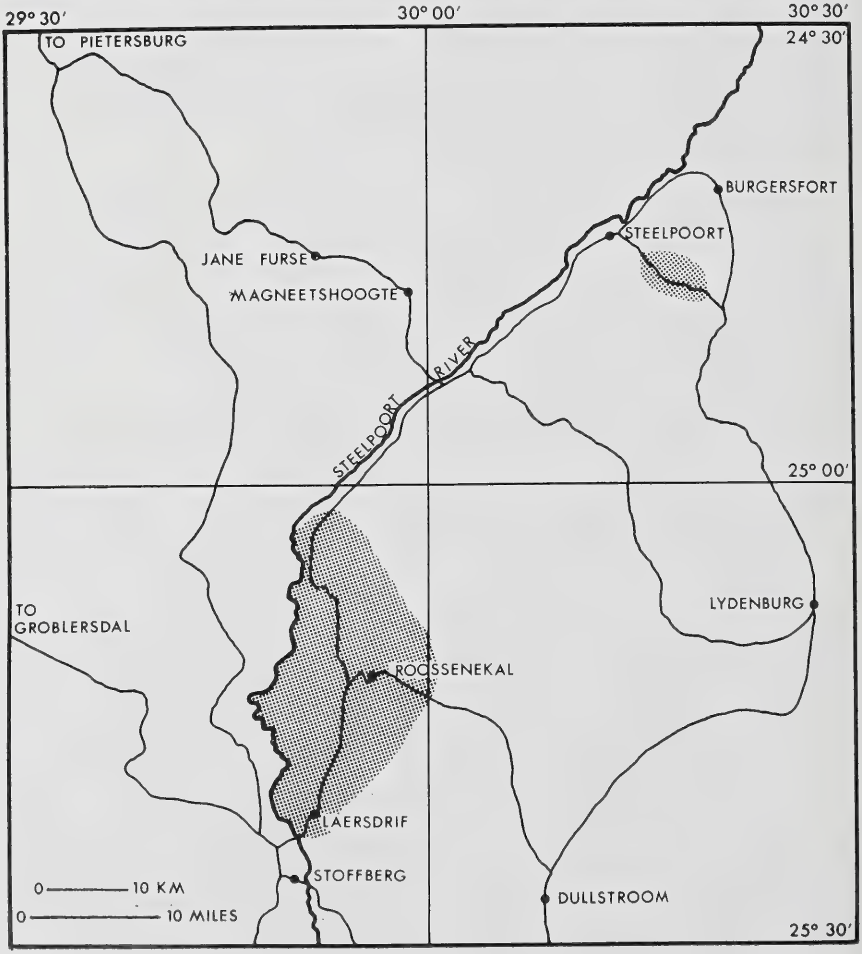

FIG. 1. — Map showing portion of Sekukuniland in the eastern Transvaal. The shaded areas indicate the known distribution of the densely pubescent **Acacia** specimens.

Growth form as in *A. karroo* is either a small spreading shrub, a tree with a somewhat rounded crown, or a sparingly branched, spindle-like tree. *Acacia* is often dominant and forms dense stands.

Now to consider a few further specimens of *Acacia* from Sekukuniland. *Ross* 2089 and 2090 were growing next to each other at Laersdrif. *Ross* 2089 has the typical dense indumentum on the pods, young branchlets, leaf petioles, rachides and rachillae and the leaflets have very dense, spreading marginal cilia. *Ross* 2090, which was initially mistaken in the field for a specimen of "typical" *A. karroo*, has very sparingly pubescent leaf petioles, rachides and rachillae and only some leaflets have few marginal cilia. The pods are sparingly, but nevertheless quite distinctly, pubescent. *Ross* 2095, which was growing close to 2089 and 2090, resembles 2090 in having pods with a sparse, but nevertheless distinct, indumentum. *Ross* 2094 is from Steelpoort. Here on what is apparently an old abandoned field the plants exhibit a spindle-like growth form and it is here that the greatest development of indumentum is evident. *Ross* 2094 together with *Codd* 6702, *Codd & Dyer* 7713, 7716 from the same locality differ from the remaining specimens in having smaller leaves and fewer pinna pairs. However, these Steelpoort specimens agree well with the other pubescent specimens from Laersdrif and Roossenekal in all other characters and no grounds can be found for separating them.

Field observations and an examination of specimens indicated that specimens of *Acacia* could not be differentiated from *A. karroo* at specific level. Nevertheless, because of the dense indumentum on the young branchlets and especially on the pods of some specimens of *Acacia*, I initially felt somewhat hesitant to include *Acacia* in the already very variable *A. karroo*. In a previous paper dealing with the variation within *A. karroo* [Ross in Bothalia 10(2): 385-401, 1971] where a sparse indumentum on the young branchlets and leaves of some specimens in other areas of distribution in southern Africa was reported, in no instance were densely pubescent pods recorded. However, the very sparingly pubescent pods in *Ross* 2090, 2095 bridge the apparent discontinuity between the glabrous podded "typical" *A. karroo* and the specimens of *Acacia* with densely pubescent pods from Steelpoort. Sparingly pubescent pods do occur quite frequently in specimens from the Transvaal highveld.

It is interesting to recall that Burtt Davy in Kew Bull 1908: 158 (1908) recognized var. *transvaalensis* within *A. horrida* Willd., the variety being created to accommodate "the form met with in moist soils at the foot of kopjes, or near fonteins and streams, around Pretoria and on the high veld which is pubescent on the younger parts . . . ". Subsequently in Kew Bull. 1922: 328 (1922) after learning that the correct name for the South African plants previously referred to *A. horrida* was *A. karroo*, Burtt Davy transferred his var. *transvaalensis* to *A. karroo*. Burtt Davy's statement on p. 328 that var. *transvaalensis* "approaches *A. natalitia* E. Mey. but the rachis and rachillae are less densely pubescent . . . " is difficult to comprehend as many specimens named *A. natalitia* by Burtt Davy himself are essentially glabrous. Burtt Davy maintained his var. *transvaalensis* in Fl. Transv. 2: 347 (1932) and it is here that he mentioned the syntypes *Burtt Davy* 2468, 2807 for the first time. *Burtt Davy* 2807 is a flowering specimen and 2468 is sterile. The syntypes have only very sparingly pubescent branchlets and leaves. Burtt Davy never cited any other specimens of var. *transvaalensis* and never mentioned whether plants referred to his variety had pubescent pods or not. The degree of pubescence of the branchlets, leaves and pods exhibited by *Ross* 2090 from Laersdrif is similar to the degree of pubescence exhibited by other specimens of *A. karroo* in the vicinity of Pretoria and, with the exception of the pods, to the syntypes of var. *transvaalensis*.

Field observations and an examination of herbarium specimens indicate that there is continuous variation in the degree of pubescence from the glabrous and very sparingly pubescent plants in the vicinity of Pretoria and on the Transvaal highveld to the more densely pubescent plants in Sekukuniland. Variety *transvaalensis* was distinguished from typical *A. karroo* solely on the presence of pubescence and there does not appear to be any other distinguishing character. Pubescent specimens are found in many parts of the species range so that a rather heterogeneous assemblage of plants from all areas of distribution could be referred to var. *transvaalensis*. For example, *A. hirtella* (a synonym of *A. karroo*), which was described by E. Meyer (Comm. Pl. Afr. Austr. 1: 167, 1835) from the south coast of Natal, was distinguished from *A. natalitia* and from *A. karroo* in having pubescent leaflets and branchlets and yet specimens differ in many respects from those of var. *transvaalensis*. It is felt that var. *transvaalensis* would make a rather poor variety and consequently it is not intended to uphold the variety. The densely pubescent specimens from Sekukuniland which cannot be satisfactorily differentiated from var. *transvaalensis*, and which represent an extreme form of it, will therefore receive no formal taxonomic recognition.

It appears that on the Transvaal highveld there is a local tendency to the production of a sparse pubescence on the young branchlets, leaves and pods. However, occasionally this tendency is so extreme, for example at Steelpoort, as to alter the general appearance of the plants completely. The area between the two apparently distinct populations in Sekukuniland (see Fig. 1) is rather mountainous and consequently has not been thoroughly investigated. It is quite likely that the range of distribution is greater than reflected and that the two populations may in fact be one continuous population. The soils in this area are derived from magnetite, a fact which may be of great significance. The possibility exists that this edaphic factor plus perhaps some other evironmental influences have resulted in the development of the dense indumentum. The growth of seedlings under experimental conditions may shed light on this matter.

This decision not to uphold var. *transvaalensis* was taken after consideration of the range of variation within *A. karroo* throughout its distributional range. As discussed previously (Ross, *l.c.*) *A. karroo* is an extremely variable species in which numerous variants are recognized. The extremes of each variant, for example the densely pubescent plants from Steelpoort, are usually quite distinctive and naturally it is these extremes that attract attention. However, the extremes of each variant are linked to the "central *A. karroo* gene-pool" by numerous varied and intermediate stages that become progressively less and less distinct until a stage is reached where it is difficult to assign a specimen to a particular entity with any degree of certainty. It becomes extremely difficult to identify each entity clearly and thereby facilitate identification by other workers. It seems preferable therefore to regard *A. karroo* as an inherently variable species in which no infraspecific categories are recognized rather than to fragment the species into a number of somewhat arbitrary infraspecific entities.

Acknowledgements

I am grateful to Mr. J. P. M. Brenan, Keeper of the Herbarium and Library, Royal Botanic Gardens, Kew, for examining and commenting on a set of the densely pubescent specimens and for much valuable information.

Bothalia, 10, 3: 431—436

New and Interesting Records of African Plants

by

Various Authors

ASCLEPIADACEAE

Brachystelma cathcartense *R. A. Dyer*, sp. nov., *B. tuberoso* R. Br. et *B. campanulato* N.E. Br. affine, ab ambobus coronae lobis exterioribus et interioribus, corollae colore et pilis differt.

Herba tuberosa humilis basi sparse ramosa; tuber leviter compressum, supra concavum, 4—5 cm diam., 2 cm crassum; rami adscendentes, 5—15 cm longi, minute scabridi. *Folia* lanceolata breviter petiolata vel supera lineari-lanceolata usque 2.5 cm longa, sparse et minute scabrida. *Flores* 1—2, extra axillares, pedicellis plus minusve 8 mm longis, sepalis lineari-lanceolatis circiter 5 mm longis. *Corolla* 2—2.2 cm longa, extra glabra vel sparse pilosa; tubus campanulatus 9—9.5 mm longus, 1.8—2 cm latus, extra rubro-punctatus, intra infra medium glaber, rubro-lineatus et maculatus, supra medium rubiginosus, plus minusve hirsutus; lobi basi rubiginosi, plus minusve hirsuti, apicem versus virides, pilosi, marginibus sparse ciliatis, leviter recurvatis, apice leviter incurvato. *Corona* basi breviter tubulata; lobi exteriores 5, subquadrati, erecti 1—1.5 mm longi, bifidi; lobi interiores spathulato-oblongi leviter crassi incumbenti-erecti. *Pollinia* subglobosa compressa, circiter 0.25 mm longa.

Type: Cape, Cathcart District, on Viviandale farm, Nov. 1967, *P. F. du Toit* in PRE 31309 (PRE, holo.).

Herb with tuberous root; tuber 4—5 cm diam., about 2 cm thick vertically, rounded on under surface and slightly concave on upper surface. *Stem* 5 cm tall when first flowering, elongating to 15 cm under cultivation, sparsely branched, minutely scabrid. *Leaves* towards base of stem subsessile, lanceolate, less than 1 cm long; upper leaves longer and narrower, linear-lanceolate, up to 2.5 cm long, thinly and minutely scabrid-pubescent on both surfaces; the margin slightly folded upwards. *Flowers* 1 or 2 at a node, extra axillary, sometimes on opposite sides of the node, each subtended by a short bract, with carion odour; pedicel about 8 mm long, minutely pubescent; sepals linear-lanceolate, about 5 mm long. *Corolla* 2—2.2 cm long, 10-ribbed, 5 ribs extending to the sinuses, the others to the tips of the lobes, with minute recurved teeth at the sinuses (Huernia-wise), glabrous or with few scattered hairs on outer surface; tube subcampanulate 9—9.5 mm long, spreading somewhat abruptly above and 1.8—2.0 cm across rim; lobes 1.1—1.3 cm long, 9—10 mm broad across base, triangular, ciliate with slightly swollen hairs towards sinuses; finely maroon-spotted on outside of tube and base of lobes; basal $\frac{1}{2}$ of tube within yellow, marked with small radial maroon stripes and spots, becoming solid maroon and with long hairs above and on base of lobes, with the tips green and shortly hairy, but somewhat variable; margins somewhat recurved, apex incurved. *Corona* arising from above base of staminal column, with saucer-shaped tube 0.5 mm high; outer lobes subquadrate 1—1.5 mm long, bifid to about $\frac{1}{2}$ way with slightly spreading lobules; inner lobes arising from within basal tube, incumbent-erect, slightly thickened, spathulate-oblong, 2.5—3 mm long. *Pollinia* about 0.25 mm long, subglobose,

compressed, with narrow translucent inner margin; caudicles slender; carrier narrowly winged.

Cape.—3227 (Stutterheim): Viviandale farm near Cathcart, Nov. 1967. (—AC) *P. F. du Toit in PRE 31309;* GRA without No., 1970 (—AC), *P. F. du Toit in PRE 31310.*

Brachystelma cathcartense was discovered by Mr. P. F. du Toit, Pasture Research Officer, in November 1967 in the eastern Cape, Cathcart district, on the farm Viviandale. The species was noted to occur in several of the farm camps, although nowhere plentiful. Mr. Du Toit took tubers to the office of the Botanical Research Institute in Grahamstown in 1967, where Miss Grace Britten induced one tuber to flower quite freely each year. Further collections were made by Mr. Du Toit in February and November 1970. The main flowering period is during November and December. Fine colour photographs were taken by Col. Roy Bayliss and Messrs. Hepburn & Jeanes in 1969. There was a certain amount of variation in size, pubescence and colouration of the flowers of different tubers but nothing to warrant taxonomic recognition. One has to bear in mind the variation which results from the preservation of flowers under different conditions and at different stages of maturity; for instance the more the corolla shrinks in drying, and it may be to less than a quarter of its original size, the denser will appear the pubescence. Miss Britten records separate plants with the corolla marked with dark purple transverse lines in the tube, maroon above and with scattered purple hairs tipped with yellowish-green; others were yellowish-green with dark purple transverse lines in the tube and mulberry-coloured above with numerous purple hairs giving it a velvety appearance; and yet others were green with darker green and purple spots in the tube and purplish-black above with purple hairs.

At first it was thought that *B. cathcartense* might be a form of *B. meyerianum* Schltr. from the same geographic region, but Miss Britten noted that the latter is of sprawling habit and favours rock crevices for its growth. It was noted also that the corolla-tube is considerably narrower. Further examination showed that the outer corona is dissimilar, although Brown's description in Flora Capensis 4, 1: 842 (1908), based on dried material, is somewhat misleading. He describes 5 transversely rectangular lobes (outer corona) with a central linear obtuse point (inner corona-lobes). The outer corona in *B. meyerianum* is actually in the form of V-shaped pockets between the inner corona-lobes and it is their united adjacent shoulders which form the rectangular shaped lobes behind the inner corona-lobes to which Brown refers.

In the shape of the corolla it seems that *B. tuberosum* R. Br. and *B. campanulatum* N.E. Br. are the nearest affinities to our species. But besides marked differences in colouration and pubescence, the difference in coronal structure is very marked between *B. campanulatum* and *B. cathcartense*. It probably is with *B. tuberosum* also, but in this case the original description is inadequate, merely stating that the corona is 5-cleft with the segments triangular and conniving at the points. This could indicate that the outer corona consists of V-shaped pockets similar to those of *B. campanulatum* and *B. meyerianum*. *B. cathcartense* is no exception to the rule that the flowers give off a carrion-like odour.

In applying the epithet *cathcartense* to this species the name commemorates the type locality, in fact the only locality so far established, and at the same time Sir George Cathcart, Governor at the Cape of Good Hope, 1852-1854, and who was killed in the Crimean War at the battle of Inkerman in 1854.

Xysmalobium trauseldii *R. A. Dyer,* sp. nov., *X. orbiculari* (E. Mey.) D. Dietr. affine, sed habitu minore, capite gynostegii peltato concavo exserto differt.

Asclepias sp., Trauseld, Wild Flows. Natal Drakensberg 154 (1969).

Herba perennis, radice tuberosa elongata. *Rami* 1—2 erecti, caudicis apice editi, simplices, 20—35 cm alti, 5—10 mm crassi, puberuli. *Folia* 6—12, paribus oppositis, breviter petiolata; lamina late elliptico-oblonga, oblonga, vel oblongo-lanceolata usque 15 cm longa 8 cm lata, basi rotundata vel cordata, glabra, margine minute scabra. *Umbellae* 1—4, pedunculatae multiflorae; pedunculi 5—6 cm longi, puberuli, plus minusve extra-axillares; pedicelli 1—1.3 cm longi. *Sepala* lineari-lanceolata, 5—7 mm longa, pilis curvatis pubescentia. *Corolla* prope basin divisa; petala 9—10 mm longa, circiter 6 mm lata, expansa, apice leviter reflexa, extra glabra, intra minute papillosa, cremea demum erubescens. *Coronae lobi* carnosi contigui, 3 mm alti, 2.5 mm lati, 1.5 mm crassi, columnae adpressi, intra margines interiores concavi, medio lobis 2 minutis praediti. *Pollinia* cylindrica, 0.6 mm longa. *Gynostegii caput* exsertum, peltatum, concavum, 4.5—5 mm diam., margine plus minusve undulato vel leviter 5-angulato. *Folliculus* 1, puberulus, 10—11 cm longus, 1.5—2 cm diam., pedunculo 13 cm longo; semina 7—8 mm longa, 4—4.5 mm lata, rugosa.

Type: Natal, Estcourt District, Giants Castle Game Reserve, Nov. 1969, *Trauseld* 1107, in PRE 30955 (PRE, holo.).

Perennial herb; rootstock tuberous up to 15 cm long and 25 cm diam., hard, corky, fissured and pitted. *Stems* 1—2 per annum, erect, unbranched, 20—25 cm tall, 5—10 mm thick, puberulous, with 3 to 6 pairs of leaves. *Leaves* variable; petoile 0—7 mm long; blade broadly elliptic-oblong, oblong or oblong-lanceolate, lowest pair 2.5—5 cm long, 2—4 cm broad, upper pairs 7—15 cm long, 3—8 cm broad, rounded or cordate at base, sometimes stem-clasping, glabrous except for minutely scabrid margin; median vein prominent below and slightly sunken on upper surface. *Umbels* 1—4 per stem from upper nodes, pedunculate, many-flowered. *Peduncles* more or less extra-axillary at the nodes, 5—6 cm long, stout, erect, thinly puberulous; pedicels 10—13 mm long. *Calyx* deep rose-coloured, divided to base; sepals linear-lanceolate, 5—7 mm long, pubescent on back with minute curved haris. *Corolla* divided nearly to base, cream turning deep rose; petals 9—10 mm. long, about 6 mm broad, spreading, with slightly recurved apex, glabrous on outer surface, minutely papillate within. *Staminal-column* arising from base of corolla. *Corona-lobes* cream-coloured, arising about 0.5 mm from base of staminal column, fleshy, subquadrate, contiguous 3 mm tall, 2.5 mm broad and 1.5 mm thick, obtuse with depressions on inner surface on either side of the median thickening and 2 minute lobules slightly above the point of attachment; anther-thecae hard, filaments adpressed to style base; stigma exserted above stammal column, 4.5—5 mm diam., peltate, concave, more or less crenate on margin and 5-angled, pale yellow turning red. *Pollinia* cylindric about 0.6 mm long with slender caudicles laterally attached. *Follicle* single by abortion, on stout peduncle 13 cm long, puberulous 10—11 cm long, 1.5—2 cm diam., seeds 7—8 mm long, 4—4.5 mm broad, rugose, concave on one surface, with apical tuft of hairs.

NATAL. — 2828 (Bethlehem): Mont-aux-Sources National Park, grassveld, 1,500 m alt., very rare, Nov. 1963 (—DB), *Trauseld 117* (PRE). 2929 (Underberg): Giants Castle Game Reserve, on bank of Bushmans River in black turf, about 1,800 m alt., Oct. 1966 (—AD), *Trauseld 1107, in PRE 30955.*

Mr. W. R. Trauseld, field officer on the staff of the Natal Parks, Game and Fish Preservation Board, after whom this species is named, found the first specimen in November 1963 in *Themeda triandra* grassveld at Mont-aux-Sources.

The second record was in October 1966 on the bank of the Bushmans River at Giants Castle. In spite of diligent searching in these areas, only a very few other plants of the species were located, the most recent being a robust specimen from Giants Castle in November, 1969, *Trauseld* 1107.

Among southern African species, *Xysmalobium orbiculare* (E. Mey.) D. Dietr. shows the closest affinity to *X. trauseldii* which, however, is readily distinguished by the unusual feature of a protruding stigma from the apex of the staminal column. In this character *X. trauseldii* has an affinity with *X. angolense* Scott-Elliot from distant Angola.

Mr. Trauseld took pains to preserve flowers in solution in different stages of maturity. Dissections from the dried specimens failed to reproduce the original shape of the fleshy corona-lobes, which once more highlights the value of a good spirit collection as an adjunct to herbarium specimens. Illustrations of the habit of the species and of an inflorescence, with a central open flower, are shown in the recently published book by Mr. Trauseld, entitled Wild Flowers of the Natal Drakensberg, p. 154 (1969).

R. A. Dyer.

* * *

FLACOURTIACEAE

A New Species of Dovyalis

Dovyalis revoluta *Thom*, sp. nov., foliorum forma et nervatura *D. zeyheri* similis sed praecipue lobis calycibus revolutis, baccis subrotundis papillosis, seminibus lanatis differt.

Arbor vel frutex 5.4 m altus, saepe armatus, dioecius interdum floribus polygamis. *Folia* alterna, petiolata; lamina coriacea obovata, 1.5—5 cm longa, 1—3 cm lata, glabra, e basi triplinervia. *Flores* feminei solitarii, lobis calycibus revolutis, persistentibus. *Fructus* suborbiculatus, papillosus. *Semina* lanata.

Type: Natal. — 2832 (Mtubatuba): False Bay Park, *Moll 5112* (PRE, holo.).

Tree or shrub up to 5.4 m tall, deciduous; dioecious or rarely polygamous, often armed with glabrous spines up to 6 cm long, bark light grey to black, lenticellate. *Leaves* exstipulate, alternate, petiolate; blade coriaceous, obovate, 1.5—5 cm long, 1.3 cm broad, glabrous, 3-veined from the base; apex obtuse, base cuneate, margin light green, entire or faintly serrate; petiole 3—5 cm long, glabrous. *Male flowers* light green, pedicellate, in fascicles of 2—6; pedicels surrounded at the base by small hairy scales, 3—4 cm long. *Calyx* 4—5 lobed; lobes 3—5 mm long, ovate-elliptic, pubescent. *Coralla* 0. *Stamens* 15—25, 3 mm long; filaments surrounded at the base by glabrous nectaries which form a honeycomb structure; anthers bilocular, dehiscing by means of longitudinal slits. *Female flowers* yellow-green, pedicellate, solitary; pedicels surrounded at the base by small pubescent scale-like bracts, 4—7 mm long. *Calyx* 5—7 lobed; lobes 4 mm long, linear-elliptic, pubescent, revolute. *Ovary* unilocular, surrounded at the base by a glutinous, sparsely hairy, lobed annulus, with 2 parietal placentas, each placenta with one ovule; styles 2, channeled. *Fruit* a subglobose berry, 2 cm in diam., minutely papillose, orange when ripe. *Seeds* 2, embedded in fleshy pulp, 13 mm long, densely woolly.

Recorded from Zululand in sand forests.

Natal. — 2732 (Mtubatuba): False Bay, *Edwards 3199; Gerstner 4735; Moll 2823; 5112; Ward 4781.*

The *Dovyalis* species in South Africa can be divided into two distinct sections. *D. caffra* is the only representative of the one section and all the other species, including *D. revoluta,* form the other section. *D. caffra* is charac-

terised by: (1) the leaves being fascicled on cushion-like abbreviated shoots; (2) the ovary having 5—7 placentas, each placenta bearing two ovules; and (3) the fruit being 3—4 cm in diameter with many seeds. All the other species have the following characteristics: (1) the leaves are alternate, not fascicled; (2) the ovary has 2—3 placentas, each placenta bearing one ovule; and (3) the fruit is 0.6—2 cm in diameter with 1—3 seeds.

Although *D. revoluta* and *D. caffra* are placed in different sections, they have a character in common, namely, their suborbicular fruits, whereas the remaining species have oblong fruits.

D. revoluta and *D. lucida* are the only species in which the exocarp of the fruit is papillose. The exocarp in the other species is either glabrous or hairy. The leaves of these two species are, however, very distinct. *D. revoluta* has obovate leaves with an obtuse apex, while the tertiary veins are not as prominent as the primary and secondary veins. *D. lucida*, on the other hand, has rhomboid, acuminate leaves and the tertiary veins are as prominent as the primary and secondary veins.

The leaf shape and venation of *D. revoluta* and *D. zeyheri* are very similar and the two species might be confused in the vegative state. *D. revoluta*, however, posesses one unique character which distinguishes it from all the other species: the calyx lobes of the female flower are revolute before and at the fruiting stage. In all the other species they are either erect or bent outwards, not revolute. The seed testa in *D. revoluta* is densely woolly while in all the other species the testa is glabrous or hairy.

Fruiting specimens of *D. revoluta* have been collected by various collectors near False Bay in Zululand over several years. It was only in October 1970 that Mr. Moll of the Botanical Research Institute, who is engaged on a botanical survey of the area, succeeded in finding male and female flowers.

A fruiting specimen, *Galpin* 8074, collected in 1911 near the Zwart Kei River in the Eastern Cape, may belong in *D. revoluta*, though the fruits are somewhat smaller. Further investigation is necessary to establish with certainty whether *D. revoluta* does in fact also occur in the Eastern Cape Province.

J. E. Thom.

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THYMELAEACEAE

A New Combination in Gnidia

C. H. Wright in Fl. Cap. 5, 2: 583 (1925) based his description of *Arthrosolen compactus* on a specimen collected by Wylie at Nigunya, 1,980 m altitude, in Natal (*Wylie* sub Wood 10531). Examination of an isotype in the Natal Herbarium, Durban, revealed that the species would be better placed in the genus *Gnidia* as the inflorescences are not in dense heads and lack the surrounding coloured membranous bracts typical of *Arthrosolen*. Phillips in his "Notes on some Genera of the Thymelaeaceae" in J. S. Afr. Bot. 10: 61-67 (1944) transferred eight of the eleven species of *Arthrosolen* enumerated in Fl. Cap. 5, 2: 6-9 to the genus *Gnidia* but he apparently overlooked *Arthrosolen compactus* which was described in the addenda on p. 583.

The combination of this specific epithet with the genus *Gnidia* has apparently never been validly published. It is proposed therefore to remedy this now by effecting the necessary combination.

Gnidia compacta *(C. H. Wr.) J. H. Ross,* comb. nov.

Arthrosolen compactus C. H. Wr. in Fl. Cap. 5, 2: 583 (1925). Type: Natal, Nigunya, *Wylie* sub Wood 10531 (NH, iso.!).

Apart from the type specimen from Nigunya (the exact locality of which is unknown) a few other specimens from Natal have been examined. These include: *Killick* 1187 (NH) from the Cathedral Peak Forest Research Station (Bergville district); *Trauseld* 464; 639 (NU) from the Giants Castle Game Reserve (Estcourt district); *Hilliard & Burtt* 5676 (NU) from the Highmoor Forest Reserve (Estcourt district) and *W. F. Wright* 234 (NU) from Storm Heights (Impendhle district).

J. H. Ross.

* * *

VITACEAE

New Combinations in Cyphostemma

In Not. Syst. 16: 113-125 (1960), Descoings published a number of new combinations in *Cyphostemma* but, because he omitted to cite the publications in which the basionyms were published, the combinations were not valid. In Kirkia 2: 139 (1961) and Kirkia 3: 20 (1963), Wild & Drummond validly published additional combinations and, in Flora Zambesiaca 2: 459 (1966), they met the requirements for certain of the combinations attributed to Descoings. Descoings corrected the remainder of his combinations in Nat. Monsp. 18: 227 (1968), but there still remain a few South African species for which combinations have not been made. These are now effected.

Cyphostemma natalitium *(Szyszyl.) J. v. d. Merwe,* comb. nov.
Vitis natalitia Szyszyl., Polypet. Rehmann 2: 45 (1889).
Cissus natalitia (Szyszyl.) L. E. Codd in Bothalia 6: 545 (1956).
Cissus connivens Lam. var. *meyeriana* Planch. in DC. Monag. Phan. 5: 584 (1887), partly; Süssenguth in Pflanzenfam. 20d: 250 (1953), partly.
Cissus glabra E. Mey. in Drege, Zwei Pfl. Docum. 173 (1843), nomen nudum; Planch. l.c. 584 (1887), in synonomy.
Cissus orientalis sensu Harv. in Fl. Cap. 1: 253 (1860), non Lam.

Cyphostemma sulcatum *(C. A. Sm.) J. v. d. Merwe,* comb. nov.
Cissus sulcatus C. A. Sm. in Burtt Davy, Flow. Pl. Ferns Transv. Swaziland 2: xx, 477 (1932).

Cyphostemma segmentatum *(C. A. Sm.) J. v. d. Merwe,* comb. nov.
Cissus segmentatum C. A. Sm. in Burtt Davy, Flow. Pl. Ferns Transv. Swaziland 2: xx, 476 (1932).

Cyphostemma oleraceum *(Bolus) J. v. d. Merwe,* comb. nov.
Cissus oleraceus Bolus in J. Bot. Lond. 47: 55 (1909).

Cyphostemma dasypleurum *(C. A. Sm.) J. v. d. Merwe,* comb. nov.
Cissus dasypleurus C. A. Sm. in Burtt Davy, Flow. Pl. Ferns Transv. Swaziland 2: xx, 476 (1932).

Cyphostemma hispidiflorum *(C. A. Sm.) J. v. d. Merwe,* comb. nov.
Cissus hispidiflorus C. A. Sm. in Burtt Davy, Flow. Pl. Ferns Transv. Swaziland 2: xx, 476 (1932).

A name which has not yet been transferred to *Cyphostemma* is *Cissus sandersonii* Harv. After a study of a wide range of modern material, it is concluded that this cannot be satisfactorily separated from *Cyphostemma cirrhosum* (Thunb.) Descoings ex Wild & Drummond, nor can a satisfactory distinction be found between the typical form of the latter and *C. cirrhosum* subsp. *transvaalense* (Szyszyl.) Wild & Drummond.

J. J. M. van der Merwe.

Bothalia, 10, 3: 437—450

Principal Components Analysis of Acacia burkei and A. nigrescens in Natal

by

J. H. Ross* and J. W. Morris*

Abstract

Four principal component analyses were carried out to study the perplexing relations within *Acacia burkei* Benth. and between it and *A. nigrescens Oliv.* Sampling methods are described in detail. Ten morphological parameters were noted from 163 plants of 21 populations. The results confirmed conclusions of earlier non-multivariate studies. The two species can be distinguished on the basis of the ten parameters and it is of doubtful value to recognize infraspecific categories within *A. burkei* as the variation within the species is continuous. The technique of principal components analysis was most useful in this study.

Introduction

Acacia burkei Benth. and *A. nigrescens* Oliv. form part of a complex of closely related species which are taxonomically most perplexing. Within this complex the degree of pubescence of the calyx is the character of prime importance in distinguishing two main groups. In their typical forms *A. nigrescens* and *A. burkei* are readily distinguishable: the former with its large leaflets and glabrous calyces and the latter with smaller leaflets and pubescent calyces. However, there are numerous plants with leaflets intermediate in shape and in size between those of *A. nigrescens* and those of *A. burkei.* Leaflet size varies considerably and an entire range from those the size of *A. burkei* to those the size of *A. nigrescens* may be found on a single plant. However, as these plants have pubescent calyces their relationship seems to be with *A. burkei* rather than with *A. nigrescens.*

This range of morphological variation within *A. nigrescens* and within *A. burkei* has been considered in some detail (Ross 1968a, 1968b). It had been customary to distinguish loosely between "small leaflet" *A. burkei* and "big leaflet" *A. burkei,* the former typically having leaflets less than 3 mm wide and the latter leaflets more than 3 mm wide. However, it was found (Ross 1968b) that the characters typifying "small leaflet" and "big leaflet" *A. burkei* were not necessarily correlated but varied independently, certain combinations of characters being commoner than others. Thus, although specimens at either extreme of the range of morphological variation could be readily sorted into two groups, there remained numerous specimens that could not be referred to either group with certainty. Consequently no infraspecific categories were recognized within *A. burkei.*

An examination of the means of the morphological parameters (see below) obtained for *A. nigrescens* (Ross, 1968a) and for *A. burkei* (Ross, 1968b) indicated that rachilla length, number of pinna pairs, number of leaflet pairs, leaflet length and leaflet width provided discontinuities between the two species. When the extremes of the morphological parameters were examined, however,

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these differences were not so readily apparent. Consequently it was decided to subject the morphological parameters to a principal components analysis in an attempt either to confirm or contradict earlier findings that *A. nigrescens* and *A. burkei* are quite readily separated, and that it is of doubtful value to recognize infraspecific categories within such an inherently variable species as *A. burkei*.

Kendall (1957) and Seal (1964) described principal components analysis in detail and one introduction to the subject, in a taxonomic setting, is given by Jeffers (1965). The results of many taxonomic applications have been published recently but as this is one of the first in South Africa the method is described in detail. In the context of this paper the object of the technique is to extract a set of components from the populations x parameters matrix which account for as much as possible of the parameter variation between the *Acacia* populations and which are mathematically independent of one another.

Sampling Technique

To assess the morphological variation within and among trees, and within and among populations, some statistical procedure was essential. The application of statistical methods brought with it the need for reliable, yet practical sampling techniques. The average herbarium collection is unsuitable, consisting often of isolated specimens selected as being "typical", either of a single plant, or of a population, or of aberrants sufficiently atypical to have attracted attention.

The prime requirement for a statistical study is that samples be representative. This proved difficult since populations were not always clearly defined and often occupied rugged terrain. Individual plants because of their large, woody, much-branched growth form and abundant foliage presented yet other sampling problems. All such problems had to be met by employing techniques that yielded representative samples, yet were essentially practicable.

Twenty leaves, twenty pods and twenty inflorescences from each plant were regarded as a satisfactory number for a sample. To obtain such samples from individual plants, a sampling method devised for and tested out on *A. robusta* Burch. (Gordon-Gray, 1965) was employed.

The distal one to two feet of not less than ten branches representative of the crown of a plant were collected.[1] In no instance were coppice shoots included since preliminary work showed that the leaves of such shoots differ, either in size or in pubescence. The branches collected from any one plant constituted a sample.

Each sample was treated separately. All mature leaves were stripped from the branches, heaped together and thoroughly mixed. Immature leaves were ignored. From this heap twenty leaves were taken by an operator with eyes closed. The same procedure was followed to obtain a sample of twenty pods and twenty inflorescences.

As many populations as possible of each species, which occur scattered through Natal (almost entirely in Zululand), were visited and sampled (see Fig. 1). Most populations visited covered large areas. Because of the rugged terrain, plants growing on, or near, the roadside were sampled. Availability alone governed the haphazard intervals at which plants were sampled. As far

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1. It was appreciated at the outset that a truly random sampling method, such as 'Randomised Branch Sampling' (Jessen, 1955), was not practicable in this study. Consequently the word 'random' has been omitted throughout, lest its use infringe mathematical requirements. In all sampling procedures followed, however, care was exercised to ensure that samples were representative and without bias.

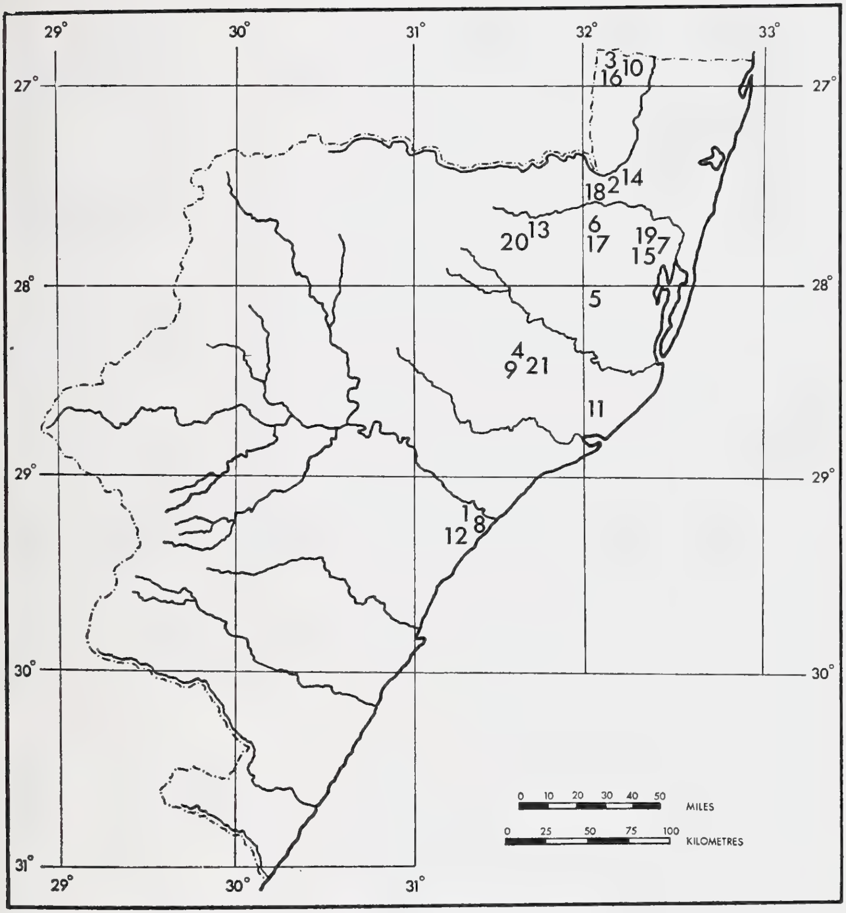

Fig. 1. — Localities of sampled populations in Natal.

as possible, ten plants were sampled from each population, but where populations were small fewer were sampled. A rough sketch map of the population was made on which the positions of the sampled plants were plotted. Each plant sampled was identified by means of a numeral painted on the bark. This was important since it was usually necessary to re-visit the plants as few had flowers and ripe pods contemporaneously.

The morphological parameters for each of the twenty leaves and pods which constituted the sample from each tree were:-

1. Petiole length (mm).
2. Rachis length (mm).
3. Leaf length (mm).
4. Rachilla length (mm) (the length of the right-hand member of the rachilla pair central on the leaf, abaxial surface uppermost).

5. Number of pinna pairs (mean).
6. Number of leaflet pairs (mean).
7. Leaflet length (mm) (length of the leaflet midway along the right-hand member of the rachilla pair central on the leaf, abaxial surface uppermost).
8. Leaflet width (mm) (as for leaflet length).
9. Pod length (mm).
10. Pod width (mm).

Means for each tree, referred to below as tree means, and for each population, referred to as population means, were calculated. Parameter means for the 15 populations of *A. burkei* (1-15) and the six populations of *A. nigrescens* (16-21) are given in Table 1.

Table 1. — Population means for each morphological parameter. The parameters are enumerated in the text and the localities of the populations are indicated in Fig. 1.

Population Number	Parameter 1	2	3	4	5	6	7	8	9	10
1	24.0	42.7	66.7	22.7	3.0	4.0	11.4	5.2	95.2	14.7
2	20.8	38.6	59.4	20.6	2.0	2.0	11.1	6.5	101.1	19.1
3	18.5	53.6	72.1	28.6	4.4	4.9	13.1	6.2	108.2	18.0
4	17.8	46.8	64.6	23.4	6.4	9.7	7.6	2.7	87.9	15.7
5	17.1	46.1	63.2	26.1	6.3	9.4	7.9	3.1	131.8	17.2
6	16.0	47.0	63.0	24.1	5.6	6.2	8.3	3.8	117.3	21.2
7	15.8	38.0	53.8	19.4	4.5	4.1	8.4	4.4	81.4	20.2
8	15.6	45.0	60.6	25.8	7.8	11.2	5.2	2.1	73.1	16.5
9	15.3	36.0	51.0	20.8	4.3	4.0	10.3	5.9	72.0	18.6
10	14.6	47.7	62.3	25.3	7.6	10.9	6.6	2.6	101.2	16.2
11	13.2	34.6	47.8	18.0	8.0	12.2	4.6	1.7	75.4	18.1
12	12.8	28.4	41.2	19.2	5.6	8.8	5.5	2.3	78.3	17.9
13	12.8	31.8	44.6	20.4	4.0	3.0	9.5	5.1	84.3	18.7
14	11.0	34.3	45.3	19.5	7.1	10.7	5.1	1.7	71.5	16.9
15	10.2	31.4	41.6	20.0	8.6	11.1	4.1	1.4	104.1	18.3
16	19.9	42.3	62.2	9.5	2.9	1.0	22.9	18.7	109.4	20.8
17	17.1	40.8	57.9	8.0	3.1	1.0	21.3	17.3	105.1	15.2
18	14.8	38.2	53.0	6.6	3.1	1.0	20.9	15.6	106.0	17.1
19	14.4	37.2	51.6	8.3	3.2	1.0	20.7	17.1	106.7	17.9
20	14.4	29.9	44.3	10.8	3.0	1.0	22.7	17.1	108.3	17.3
21	13.7	28.8	42.5	7.5	3.0	1.0	18.0	14.6	115.0	16.6

Data Analysis

Four principal component analyses were performed on the available data. Firstly, population means for both *A. burkei* and *A. nigrescens* were used and secondly, tree means for both species were used. The third and fourth analyses were carried out on, respectively, population means and tree means for *A. burkei* alone. Thus the raw data matrix (population x parameters) for the first analysis contained 21 population means, the second 163 tree means, the third 15 population means and the fourth 118 tree means. In each analysis all ten morphological parameters were used. The raw data for the first and third analysis are given in Table 1. Shortage of space precludes inclusion of the raw data for the second and fourth analysis but it is available from the authors on request.

For each analysis the first step was the computation of correlation co-efficients between each parameter and each other one over all population or tree means, resulting in a symmetrical 10 x 10 matrix. The principal components were extracted from this matrix.

An eigenvalue and eigenvector are associated with each principal component. The value indicates the proportion of the total variation accounted for by the component and thus the "importance" of the component, and the vector gives the weighting of each parameter. Components are extracted in descending order of eigenvalues, hence the name principal components. The vector is scaled so that the highest value is unity. In practice it has been found that parameters having weightings of over 0.7 and under —0.7 are important, the importance being proportional to the absolute value.

Two-dimensional scatter diagrams were constructed from the analyses. The position of a population along an axis is found by summing the products of the eigenvector and parameter vector for the population.

Results and Discussion

First Analysis

Eigenvalues and eigenvectors resulting from the first analysis are given in Tables 2 and 3, respectively. Inspection of Table 2 shows that almost half the variation within the correlation matrix is extracted by the first component, that over 90 per cent is extracted by the first four components and virtually all is extracted by the first six components. Further discussion will be limited to the first three components which account for 88 per cent of the variation.

Table 2. — Eigenvalues of the first seven components extracted by the first analysis.

Component	Eigenvalue	Percentage of variability	
		Component	Cumulative
1	4.846	48.467	48.467
2	2.937	29.379	77.847
3	1.057	10.577	88.424
4	0.557	5.575	94.000
5	0.358	3.583	97.583
6	0.184	1.840	99.424
7	0.044	0.449	99.873

Table 3. — Eigenvectors of the first three components extracted by the first analysis.

Parameter Number	Eigenvectors corresponding to component: 1	2	3
1	0.295	*0.848*	—0.833
2	—0.176	*0.926*	0.149
3	—0.030	*1.000*	0.052
4	*—0.836*	0.493	—0.045
5	*—0.930*	—0.161	0.274
6	*—0.968*	—0.037	0.141
7	*1.000*	0.008	—0.012
8	*0.992*	—0.102	0.042
9	0.699	0.383	0.282
10	0.206	—0.074	*1.000*

The morphological parameters contributing most to the first component's variation are 4, 5, 6, 7 and 8 (values given in italics in Table 3). The first three parameters and the last two are positively correlated between themselves, but the two groups are negatively correlated. Parameter 9 also has a high weighting on the first component. Parameters 1, 2 and 3 contribute most to the second component and parameter 10 is the only important one on the third component.

Positions of the populations along the first and second and first and third components are given in Fig. 2. A clear discontinuity between *A. burkei* and *A. nigrescens* is shown along the first component. There is also a discontinuity

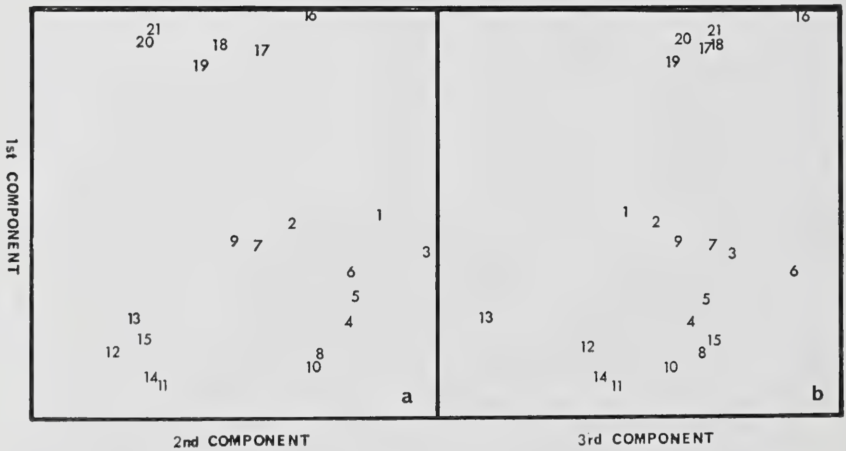

Fig. 2. — Positions of **A. burkei** (1-15) and **A. nigrescens** (16-21) populations plotted against the first and second components (a) and the first and third components (b) of the first analysis.

on the second component within *A. burkei*. However, on the third component there are no distinct discontinuities within *A. burkei* although population 13 is somewhat separate from the remaining populations. Within the *A. nigrescens* populations a cluster is formed by all the populations except 16 which is somewhat separate, particularly along the third component. Very little variation is evident within *A. nigrescens* along the first component.

Figure 2 indicates a definite distinction between *A. burkei* and *A. nigrescens* based on the sampled populations and on the morphological parameters used, and suggests that *A. burkei* is a more variable species than *A. nigrescens*. As almost three times more *A. burkei* than *A. nigrescens* populations were sampled, it is not possible to conclude with certainty that the former is the more variable species, but a trend which supports findings of previous, non-multivariate studies (Ross 1968a, 1968b) is evident. The reason for the greater variation within *A. burkei* has not been studied.

Parameters responsible for the separation of *A. burkei* and *A. nigrescens* are those mentioned above, with high absolute values within the first eigenvector. Likewise, parameters responsible for the spread amongst *A. burkei* populations along the second and third components are those with high absolute values within the second and third eigenvectors respectively. The values for three parameters which have high absolute values within the first eigenvector are plotted in Figure 3

Fig. 3. — (a) Rachilla length (parameter 4), (b) number of leaflet pairs (parameter 6) and (c) leaflet width (parameter 8) of populations plotted against the first and second components of the first analysis.

against the first and second components of Figure 2a. The clear difference between the two species with respect to these parameters can be seen. It will be noticed that better gradients along the first component are shown by number of leaflet pairs and leaflet width than by rachilla length. As rachilla length has an eigenvector value of only 0.636 a very good fit is not expected. The good gradient along the second component is, however, expected as rachilla length has the highest eigenvector value on this component.

In Figure 3 the first two parameters are positively correlated because in both cases the higher values are found amongst the *A. nigrescens* populations. As the higher values for leaflet width are found amongst the *A. burkei* populations, leaflet width is negatively correlated with rachilla length and number of leaflet pairs.

The positive and negative correlations discussed here and earlier had been discovered before the multivariate analysis was undertaken. The negative correlation of parameters is because the longer leaves have relatively fewer pinna pairs and, similarly, long rachillae have relatively fewer pairs of larger leaflets. Conversely, short rachillae carry a larger number of smaller leaflets. The agreement between what was known and the results of the analysis add to one's confidence in the technique.

Table 3 reveals that petiole length, rachis length and leaf length are the most important characters on the 2nd component and that pod width is the most important character on the 3rd component. As these characters mainly affect the distribution of *A. burkei* populations within the ordination, they will be discussed later where analyses without the presence of *A. nigrescens* populations are presented. The first two analyses were undertaken to study the relationship between the two species and not within each.

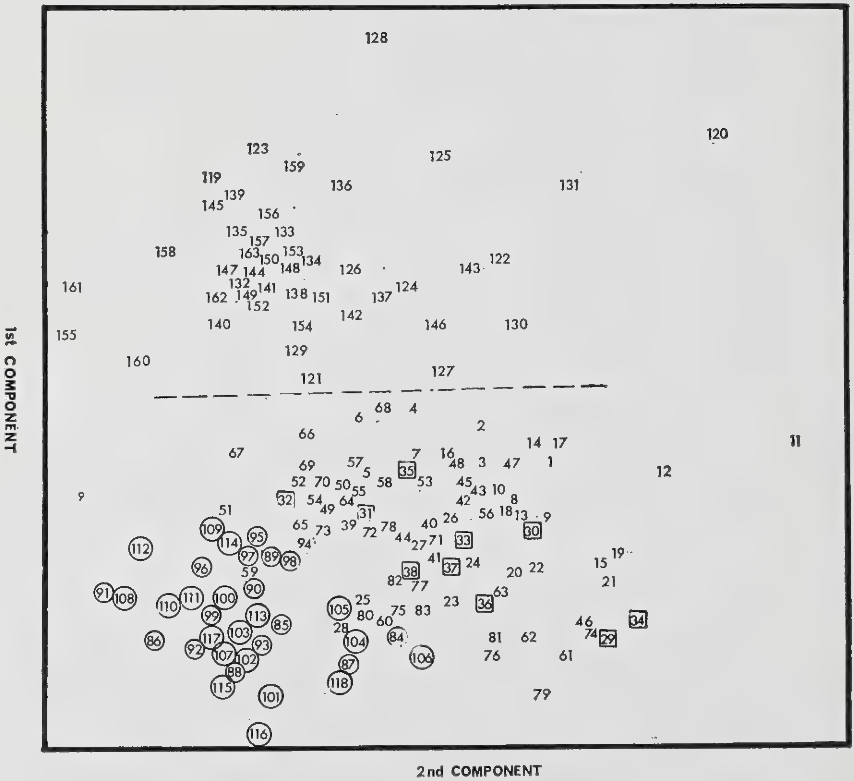

Fig. 4. — Positions of **A. burkei** (1-118) and **A. nigrescens** (119-163) tree means plotted against the first and second components of the second analysis. Means for populations 11-15 are circled and means of population 5 are boxed. A dotted line separates **A. burkei** from **A. nigrescens** populations.

Second Analysis

Tree means for *A. burkei* and *A. nigrescens* are plotted against the 1st and 2nd components in Figure 4. Although there is not a clear discontinuity, the two species are completely separated by the first component.

It is known that *A. burkei* and *A. nigrescens* are distinct species and that they are readily distinguished on the degree of pubescence of the calyx. This character, being of the presence/absence type, was not mixed with the other characters which are approximately continuous. The object of using the data, even though this taxonomically significant character had been omitted, was to establish whether or not the two species could still be separated by multivariate analysis. Certain trees of *A. nigrescens* (e.g. 121 and 127) are similar to certain trees of *A. burkei* (e.g. 4, 6, 68) with regard to the 10 characters sampled but the usual clear distinction between the species is indicated in Figure 4 by the two distinct clusters formed along the first component.

As in Figure 2, there is a tendency for the *A. burkei* trees to be more spread along the 2nd component than are the *A. nigrescens* trees. Populations 11—15, represented in Figure 4 by trees numbered 84—118 (circled), are again in proximity although in this instance there is no discontinuity between these trees and the remainder as in Figure 2. It was appreciated at the outset that population means were of limited value but they give a useful summary of the situation. Comparison of Figure 2 with Figure 4 shows how erroneous a picture can be obtained from the use of population means alone. Furthermore, in Figure 4, where the means of each tree were used, it is seen that there is considerable variation within each population. For example, population 5 of Figure 2 is represented by trees numbered 29—38 in Figure 4.

Third Analysis

For the third analysis population means for *A. burkei* alone were used. Inspection of the eigenvalues showed that over 54 per cent of the variability within the correlation matrix was extracted by the 1st component and over 90

TABLE 4. — Eigenvectors of the first three components extracted by the third analysis.

Parameter Number	Eigenvectors corresponding to component: 1	2	3
1	*0.945*	0.000	—0.141
2	*0.728*	*0.962*	0.057
3	*0.893*	*0.724*	—0.008
4	0.636	*1.000*	—0.063
5	*—0.859*	*0.791*	0.093
6	*—0.780*	*0.907*	—0.073
7	*1.000*	—0.406	—0.030
8	*0.892*	—0.698	0.087
9	0.683	0.580	0.410
10	—0.164	—0.183	*1.000*

per cent by the first three components together. Eigenvectors for the first three components are given in Table 4 and positions of populations plotted against the first and second and first and third components are given in Figure 5.

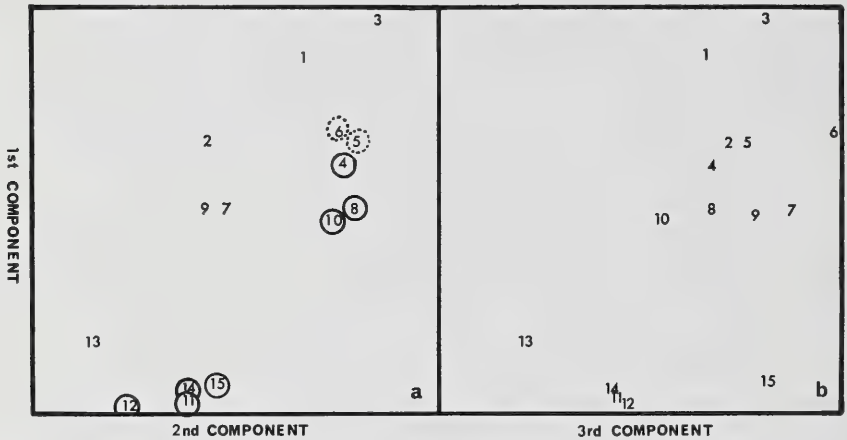

Fig. 5. — Positions of **A. burkei** populations plotted against the first and second components (a) and the first and third components (b) of the third analysis. **A. burkei** "small" populations are circled and mixed "big" and "small" populations are marked by a dotted circle.

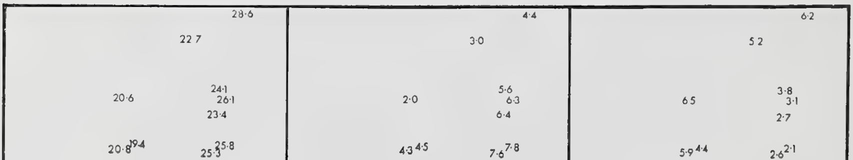

Fig. 6. — (a) Rachilla length (parameter 4), (b) number of leaflet pairs (parameter 6) and (c) leaflet width (parameter 8) of populations plotted against the first and second components of the third analysis.

With the exception of pod width all parameters have relatively high weightings along the first component, while parameters 2 through 6 have high weightings along the second component and pod width is the only important parameter along the third component. Many high weightings are often found on the first component of an analysis and can usually be attributed to overall size differences. However, the first component does not separate "big leaflet" and "small leaflet" populations as one would then expect. Instead, "big" and "small" populations occur scattered along the first axis. This is also shown in Figure 7 (see below).

The second component spreads the populations in such a way that "big" and "small" populations can be separated by a diagonal line extending from between populations 12 and 13 to between 1 and 4. This is, however, the axis of maximum variation along the first two components. This means that the "big" to "small" difference is secondary to another, more important, gradient which separates populations 11 to 15 from the rest.

In Figure 6 the three morphological characters used in Figure 3 were plotted against the first and second components of the third analysis. Similar positive and negative correlations as in Figure 3 are shown. There is an indistinct gradient along the first component in leaflet width and number of pinna pairs. Leaflet width is, however, the character on which "big" plants are separated from "small", once again suggesting that there is some other character, or characters, which are more important than leaflet width in drawing out the populations and splitting populations 11 to 15 from the rest. Table 4 reveals that petiole length, rachis length, leaf length, number of pinna pairs, number of leaflet pairs, leaflet length and leaflet width are all important in creating variation between populations. All of these characters contribute either positively or negatively to the split between populations.

Fourth Analysis

The eigenvalues and eigenvectors of the fourth analysis are very similar to those of the third. The similarity is to be expected as the data for the third analysis are derived directly from those of the fourth. Slightly less variability

TABLE 5. — Eigenvectors of the first three components extracted by the fourth analysis.

Parameter Number	Eigenvectors corresponding to component: 1	2	3
1	*0.896*	0.287	—0.072
2	0.690	*1.000*	0.145
3	*0.835*	*0.871*	0.088
4	0.544	*0.941*	0.128
5	*—0.882*	0.691	0.206
6	*—0.809*	*0.883*	0.097
7	*1.000*	—0.345	—0.055
8	*0.943*	—0.606	—0.111
9	0.290	—0.130	*1.000*
10	—0.051	—0.538	*0.980*

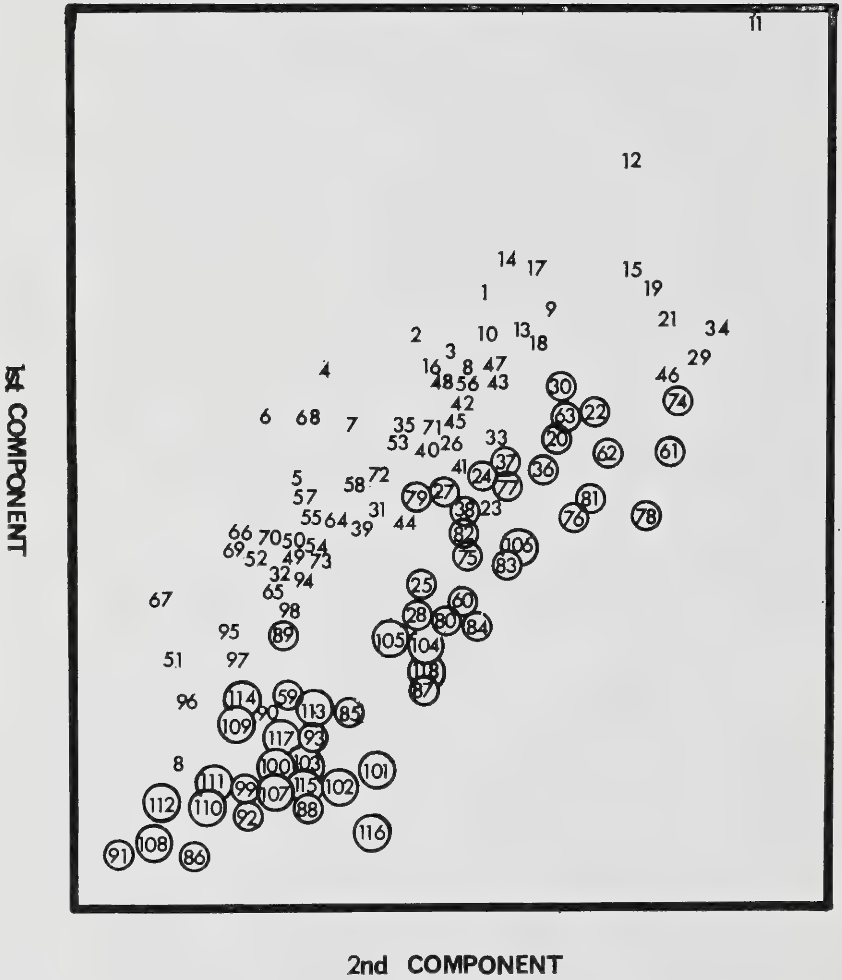

FIG. 7. — Positions of **A. burkei** tree means plotted against the first and second components of the fourth analysis. "Small" populations are circled.

(47 per cent) is extracted by the first component and a total of 81 per cent is extracted by the first three components together. Comparison of Tables 4 and 5 shows only differences of degree within each eigenvector.

The gradients and apparent division discussed under the third analysis are caused by the use of means of means (cf. first and second analyses) as no such discontinuities are obvious from Figure 7 where tree means were used. The "small" populations tend to be clustered along the lower half of the elongated scatter but merge completely with trees from the "big" populations. The scatter in Figure 7 shows that there is a greater difference between trees number 11 and 91 than between trees 6 and 78. Thus there is much more variation within both the "big" and the "small" populations than between them.

Conclusions

A. burkei and *A. nigrescens* are closely related, but nevertheless distinct species, that are readily distinguished from each other on the degree of pubescence of the calyx. In the absence of this taxonomically significant character *A. burkei* and *A. nigrescens* still separate (see Figure 4) although there is no absolute discontinuity. The analysis indicates that rachilla length, number of pinna pairs, number of leaflet pairs, leaflet length and leaflet width are additional characters that enable *A. burkei* and *A. nigrescens* to be differentiated.

There is a rather ill-defined tendency for the appearance of a discontinuity within the *A. burkei* populations. However, contrary to expectations, this discontinuity does not differentiate the "big leaflet" trees from the "small leaflet" trees for both "big" and "small" leaflet plants occur on either side of the discontinuity. Leaflet width is, therefore, not the most important character in creating this discontinuity between the *A. burkei* populations. Petiole length, rachis length, leaf length, number of pinna pairs, number of leaflet pairs, leaflet length and leaflet width are all important characters in creating this discontinuity when considered collectively. Past emphasis on leaflet width alone, a character that provides a rapid visual assessment, as a means of loosely distinguishing between "big leaflet" and "small leaflet" *A. burkei* has tended to obscure the many characters that do contribute to the range of variability within the species.

A. burkei is an extremely variable species and although the specimens at either extreme of the range of morphological variation appear distinctive it is not possible to divide this range of variation satisfactorily and thereby facilitate the recognition of infraspecific categories. As concluded previously (Ross 1968b) it is therefore of doubtful value to recognize infraspecific categories within *A. burkei*.

As a technique for studying taxonomic and ecological problems, principal components analysis is gaining in popularity overseas. After its convincing performance in the present study we hope its popularity will spread to South Africa. One of its attributes is its ability to stimulate further investigation. The reason for the apparently greater variation within *A. burkei* is an example of this stimulus.

Acknowledgements

We would like to thank Dr. D. Edwards and Mr. J. N. R. Jeffers for reading and commenting on this paper prior to its publication.

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Bothalia, 10, 3: 451—460

The Rate of Forest Tree Growth and a Forest Ordination at Xumeni, Natal

by

E. J. Moll* and D. B. Woods†

Abstract

The rate of increment in circumference at breast height of canopy tree species in the southern temperate, Mist-belt forest at Xumeni, Natal, South Africa, is very slow. The mean for all trees calculated from measurements in 1929 and 1966 is 0.201 ± 0.015 inches per year.

Results from an ordination analysis of 39 plots were interpreted in terms of a successional gradient from seral sites on steep ground, characterized by *Kiggelaria africana, Xymalos monospora* and *Fagara davyi,* to climax sites on flatter ground with *Podocarpus* spp. Two climax types are indicated, with *P. henkelli* on moist soil and *P. falcatus* on drier soils.

Introduction

The Xumeni forest lies 110 km south-west of Pietermaritzburg in the Polela magisterial district of the Natal midlands. The indigenous forest is under the control of the Government Forestry Department.

The forst occurs on the south-facing slopes of a dolerite ridge. The topography is rugged and the soils are shallow. Boulder-strewn areas are common.

The most important canopy tree at Xumeni is *Podocarpus henkelii* but generally the canopy, which has an average height of about 30 m, is of mixed composition (Moll and Haigh, 1966). The area is classified as southern temperate (Köppen's Cwb division; Schulze, 1947). According to Acocks (1953), Xumeni is Mist-belt forest, and is rich in epiphytic bryophytes, ferns and angiosperms which festoon tree boles and rocks.

In 1929 the resident forester laid out a line through the forest and on it recorded all canopy trees in 40 one chain square, systematically placed, plots (Cook, 1929). He took various measurements including circumference at breast height (CBH). In 1966 the same trees were re-measured for this parameter.

Results

1. Tree Growth

In Fig. 1 the tree CBH measurements for 1929 have been plotted against their CBH 1966. A regression line fitted for all species, shows that the average CBH increment rate over 37 years is very small. Regression lines were also calculated for the six most common species, and with the exception of *Fagara davyi* these were almost identical to the regression line for all species.

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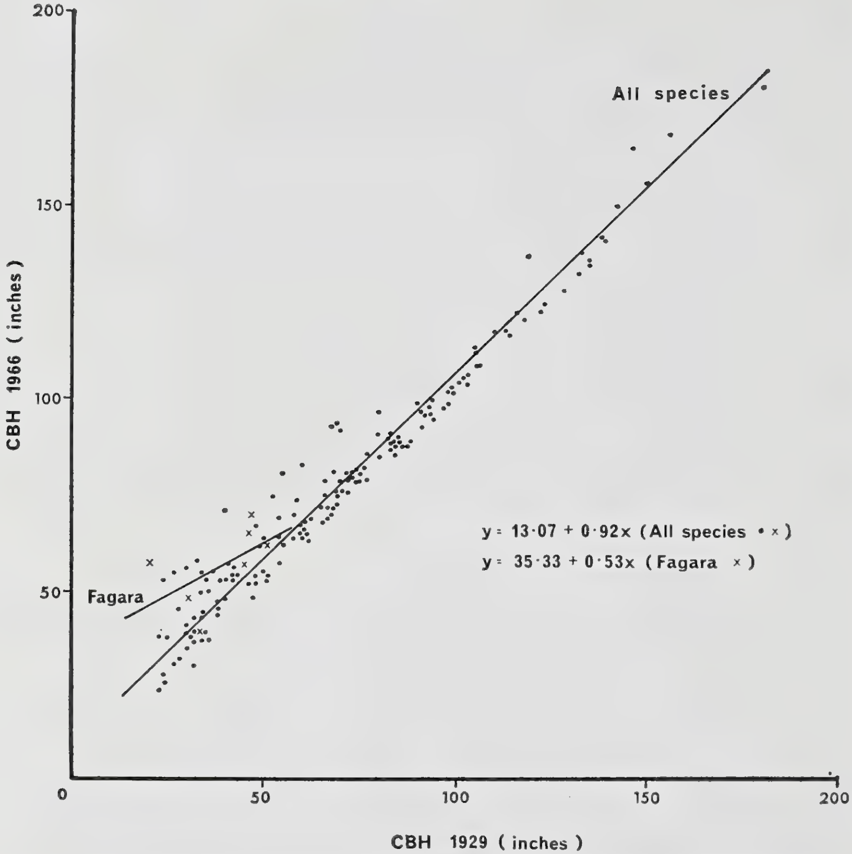

FIG. 1. — CBH increment 1929—1966 for all species in all plots, and **Fagara davyi** alone.

The regression line for *F. davyi* probably reflects that this species has the fastest rate of CBH increment of all species when young, but that the older individuals approximate to the behaviour of all species. This conclusion though tentative, there being only seven trees encountered, is in keeping with field observations on *F. davyi*.

P. henkelii exhibits a very slow rate of CBH increment (all the individuals being mature), while *F. davyi* shows the most rapid rate of CBH increment (all the individuals being comparatively young).

The rate of CBH increment of forest trees at Xumeni is very slow averaging 0.201 ± 0.015 inches* ($n = 160$) per year. Phillips (1931) quotes average increment of CBH per year in the Knysna Forest, Cape Province (Table 1). Comparing the data shown for the two species in common, the rate of increment

* As the original measurements were in feet and inches, these units have been retained rather than adopt the metric system for the recent measurements.

of *P. henkelii* in both Knysna and Xumeni is similar. The other common species, *Kiggelaria africana*, has twice the increment rate of this species in Knysna.

TABLE 1. — Mean annual CBH increment rate (in inches) of selected forest tree species at Knysna and Xumeni.

Species	Observed Rate Knysna (1924-5)	Estimated Rate ± S.E.M. Xumeni (1929-66)
Podocarpus henkelii	0.139	0.132 ± 0.017 (n = 68)
Xymalos monospora	no data	0.191 ± 0.064 (n = 13)
Podocarpus falcatus	no data	0.231 ± 0.049 (n = 15)
Kiggelaria africana	0.131	0.267 ± 0.036 (n = 26)
Fagara davyi	no data	0.459 ± 0.113 (n = 7)

In Fig. 2 the mean plot increment 1929—1966 was plotted against the mean plot CBH 1929, and a regression line fitted. The results indicate that the plots with the smallest mean CBH 1929 exhibit maximum increment, reflecting that CBH increment is inversely proportional to age of canopy tree species.

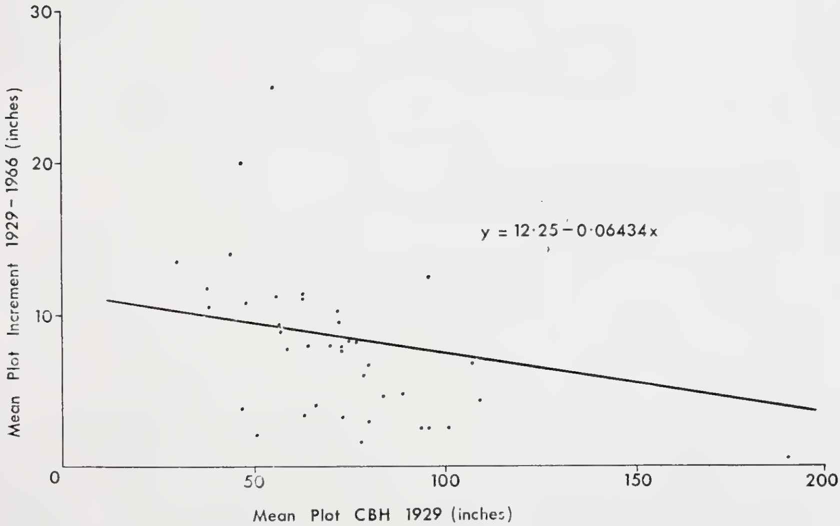

FIG. 2. — The relation of mean plot increment 1929—1966 to mean plot CBH 1929.

The CBH data were separated into 20 inch size classes and their increments drawn as a histogram (Fig. 3). As reflected in Fig. 2 the trees with the smallest CBH have increased the most, with one exception, CBH size class 141-160 inches. Upon further investigation of the four individuals in this size class, it was found that the unexpected high rate of increment was due entirely to two individuals, which were extremely fluted.

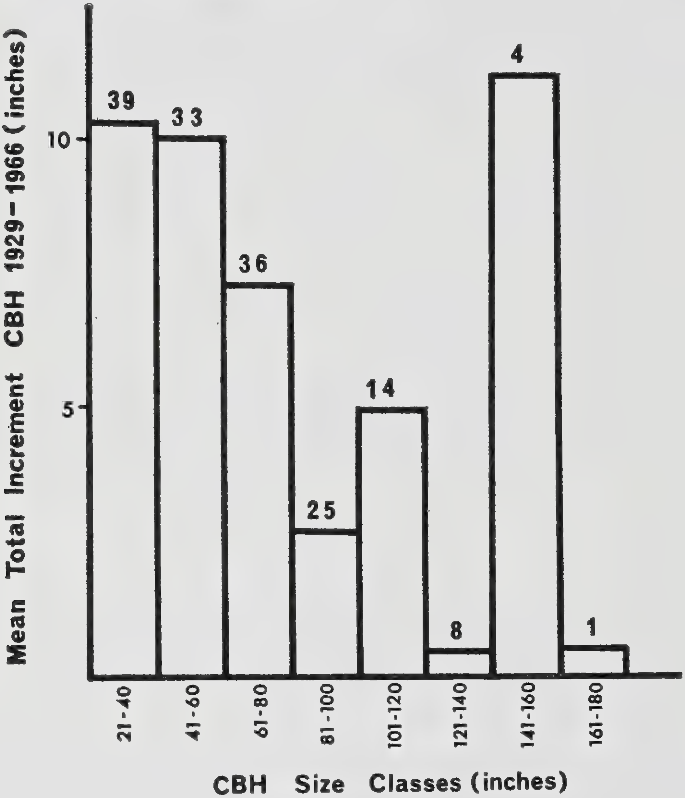

Fig. 3. — Histogram of CBH increment for 20 inch size classes (the number of individuals per size class are given above each bar).

2. Ordination

The floristic similarity of Cook's 1929 data for 39 plots (one plot was excluded because it contained no canopy tree species), was investigated using the ordination procedure developed by Bray and Curtis (1957). Two axes, X and Y, were sufficient to account for the floristic variability and the resultant two dimensional scatter diagram of points (representing plots) is shown in Figs. 4—16 (the orientation of the X and Y axes is given in each figure). Isolines are used to draw attention to (i.e. separate) high and low ratings, unless otherwise explained.

Canopy tree species (Figs 4—8)

Podocarpus henkelii and *P. falcatus* (Figs 4 and 5) separate off with centres of maximum density at the two extremes of the X axis, while *K. africana* and *X. monospora* (Figs 6 and 7) separate off at the upper end of the Y axis, the latter species being apparently unrelated to the X axis. *F. davyi* (Fig. 8) is intermediate between *K. africana* and *X. monospora.*

Canopy (Fig. 9)

Subjective estimates of canopy were made in 1966. Comparison of Figs 4 and 9, reveals that *P. henkelii* is the most important species contributing to plots with closed canopy.

Density and CBH (Figs 10 and 11)

Highest densities tend to occur in the *K. africana* and *P. henkelii* region of the ordination, while plots with trees of the largest CBH are found mainly in the *P. henkelii* and *P. falcatus* region.

Increment (Fig. 12)

Minimum plot increment 1929—1966 is found in the *P. henkelii* region and maximum increment is limited to *K. afracana, X. monospora* and *F. davyi* at the upper region of the ordination.

Slope (Fig. 13)

At each site a subjective estimate of slope was made. Although the pattern is not altogether clear, the Y axis appears related to a gradient from steep plots with *F. davyi* and other species, through gentle and flat plots with predominantly *P. henkelii.*

Rocks (Fig. 14)

A subjective estimate of the amount of surface rocks in each plot was made. The most rocky plots are found in three groups: flat plots with *P. henkelii,* flat and gentle plots with, predominently, *P. falcatus* and three plots with *K. africana.*

Mist (Fig. 15)

Nine plots are situated, approximately 100 m above the rest, on a ridge exposed to winds from the south. These plots receive most orographic mist. The soils are generally rocky and well drained, and the majority of these plots contain the highest densities encountered of *P. falcatus* (compare Figs. 5 and 15). Three plots isolated from the rest (Fig. 15), fall in the *K. africana* and *X. monospora* region of the ordination.

Selaginella kraussiana (Fig. 16)

The presence of this herb, recorded in 1966, reflects a high soil-moisture content and the majority of plots which contain this species are in close proximity to small flowing streams or noticeably dank. The distribution of this species in the ordination coincides with *P. henkelii* and the closed canopy region (Figs. 4 and 9).

FIGS. 4—16. — Distribution on the ordination of:-

4—8: Plot density of selected canopy tree species.

9: Canopy (c = closed, o = open and * = no canopy; isoline encloses region of closed canopy).

10: Plot density (absolute values plotted).

11: Mean plot CBH 1929 (CBH size classes in inches: 1 = < 60, 2 = 60—90, 3 = 91—110, 4 = > 110).

12: Mean plot increment 1929—1966 (CBH increment classes in inches: 1 = < 5, 2 = 5—10, 3 = > 10; isolines enclose regions of maximum and minimum increment).

13: Slope (S = steep, G = gentle, F = flat).

14: Rocks (R = rocky, S = semi-rocky, O = no rocks).

15: Mist (M = plots with most orographic mist).

16: **Selaginella kraussiana** present in the herbaceous field layer.

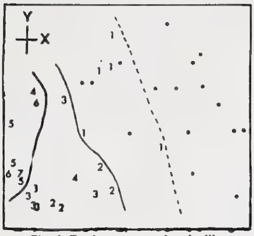

Fig.4. Podocarpus henkelii

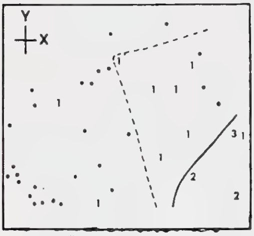

Fig.5. Podccarpus falcatus

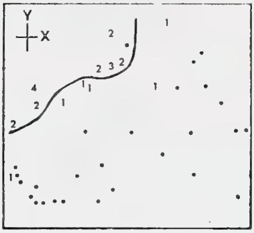

Fig.6. Kiggelaria africana

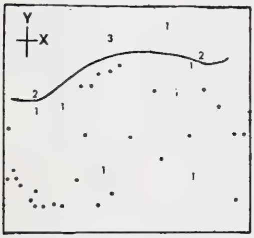

Fig.7. Xymalos monospora

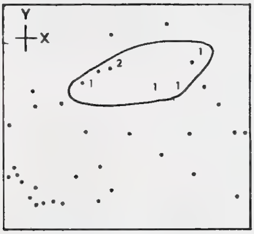

Fig.8. Fagara davyi

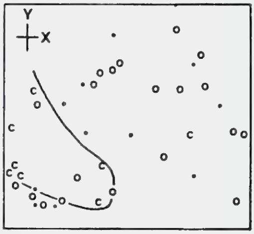

Fig.9. Canopy

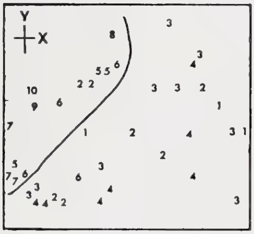

Fig.10. Density

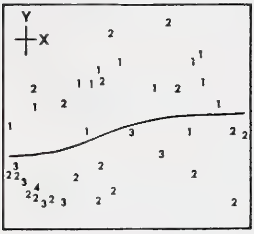

Fig.11. Mean plot CBH 1929

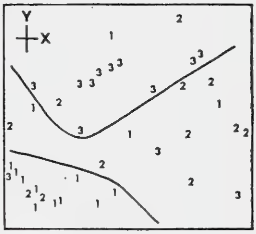

Fig.12. Mean plot increment 1929–1966

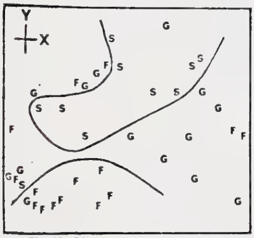

Fig.13. Slope

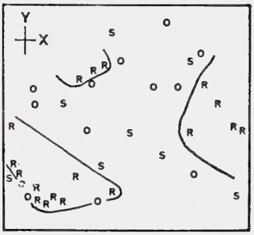

Fig.14. Rocks

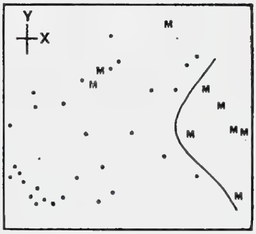

Fig.15. Mist

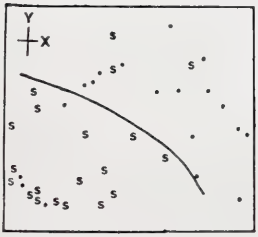

Fig.16. Selaginella kraussiana

Conclusions

1. Tree Growth

(a) Rate of forest tree growth at Xumeni is very slow, mean CBH increment for all species being 0.201 ± 0.015 inches per year.

(b) *P. henkelii* exhibits the minimum increment, *X. monospora* a higher increment approximating to the average of all trees, and *P. falcatus, K. africana* and *F. davyi* the highest. *F. davyi* shows the maximum CBH increment of all canopy species.

(c) The inverse relationship between age and CBH increment rate, well known to foresters, is clearly demonstrated for this area of indigenous forest.

2. Ordination

(i) *Specific conclusions*

(a) Two axes, X and Y, were sufficient to account for the floristic variability within the 39 plots.

(b) Comparing Figs 4 and 13—16 it appears that *P. henkelii* occurs on moist, flat, rocky terrain situated below the level of most orographic mist.

(c) Comparing Fig. 5 and Figs 13—16, it appears that *P. falcatus* is associated with gently sloping, dry, rocky areas with most orographic mist.

(d) From b and c, and with reference to Figs 10, 15 and 16, it is suggested that the X axis reflects a density gradient with *P. henkelii* and *P. falcatus* at the two extremes from respectively flat, moist, rocky plots exposed to damper atmosphere at a higher altitude. This gradient is mirrored in decrease in canopy and the occurrence of *S. kraussiana*, the presence of *S. kraussiana* showing high soil-moisture and low light intensities.

(e) The Y axis separaes the two *Podocarpus* spp. from *K. africana, X. monospora* and *F. davyi* (Figs 4—8), the latter three species growing on the steeper, least rocky slopes, and appears to show an environmental gradient from steeper, drier sites to gentle and flat, wetter sites (Figs 13 and 16).

(f) Figs 11 and 12 show the inverse relationship, stated previously, between mean plot CBH and increment, and the Y axis is related to these two measures of productivity.

(g) With reference to Figs 4—9, 11—13, 15 and 16 it is suggested that the Y axis reflects a successional trend from seral sites with *K. africana, X. monospora* and *F. davyi* to climax sites with *P. henkelii* and *P. falcatus*, the X axis showing the separation between the two climax species as described in (d).

(h) Fig. 17 summarizes the suggested site-succession relationships.

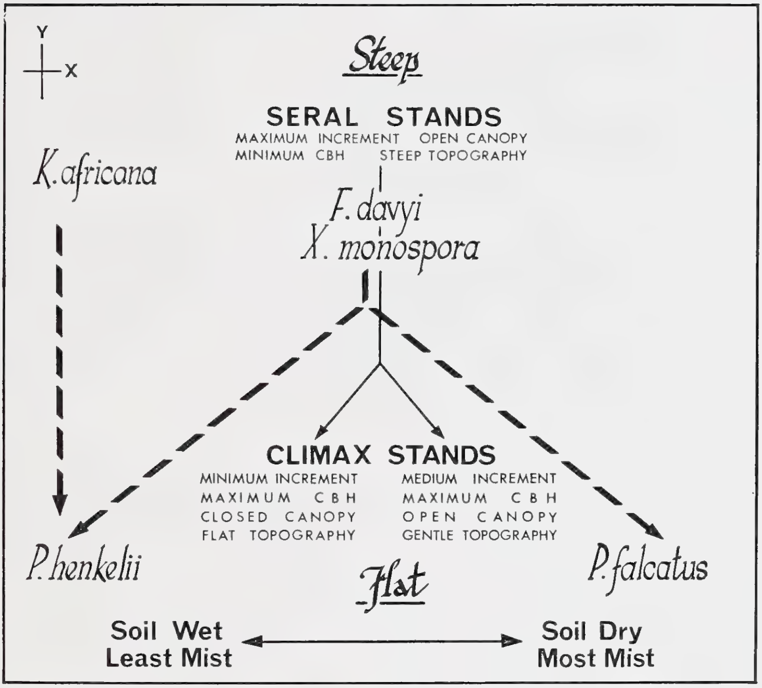

Fig. 17. — Diagrammatic representation of suggested environmental gradients and successional trend on the ordination.

(ii) *General conclusions*

(a) The plotting of information collected in 1966 onto an ordination scatter derived from data collected in 1929, and the resultant correlations, indicate that the forest environment has remained stable over this period of years. The value of plotting information onto an ordination based on floristic data collected in previous seasons has been shown to have considerable use (*cf.* Woods, 1964).

(b) Consider two hypothetical plots A and B, containing species a, b, c, d and e in the following densities:

Plot	Species	a	b	c	d	e
A		1	—	1	1	2
B		—	—	1	1	1

C (coefficient of similarity) between A and B = 75.0 per cent. Suppose species c were absent from plot B, then C would have a value of 57.1 per cent.

The plot density values at Xumeni for all species were low (Fig. 10), and it was initially suspected that such low values might have yielded little meaningful information in the matrix of similarity coefficients. However, the ordination technique employed proved

reasonably robust in view of the nature of the data used. The value of a correlation coefficient between 151 randomly selected inter-point distances and the respective dissimilarity (100 — C) values was 0.678.

(c) In view of the relative inefficiency of the ordination technique used, compared with such a technique as principal components analysis (Orloci, 1966), it is realized that the Wisconsin ordination technique does not yield high correlations between inter-point distances and similarity coefficients. However, the actual distances between points are not necessarily of paramount importance unless, for example, it is desired to classify the samples. Numerous workers have shown that the Wisconsin technique yields a meaningful overall pattern of variation in vegetation samples analysed. It has the considerable advantages of not necessarily requiring electronic computation facilities and unlike such classificatory techniques as Association Analysis, ordination is primarily useful in the study of the autecology of species when overall trends, rather than inter-point differences, are studied.

Acknowledgements

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The Flora of the Mariepskop Complex*

by

H. P. van der Schijff† and E. Schoonraad†

Abstract

The physiography, soils, climate and the main plant communities found on Mariepskop, Eastern Transvaal, are briefly described; a checklist of the plants recorded is appended.

CONTENTS

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† Department of General Botany, University of Pretoria.

Introduction

Mariepskop (altitude 1 946 m) is situated at 30° 52′ E and 24° 30′ S in the district of Pilgrim's Rest, in the Transvaal Drakensberg Mountains. Access to the area is via Lydenburg and through the Abel Erasmus Pass towards Acornhoek, or via Nelspruit and thence northwards to Acornhoek and Klaserie. Mariepskop is approximately 32 km west of Klaserie station and is not yet accessible by road through the Blyde River Valley.

The name of the mountain is derived from the Bantu chief Maripi who with his tribe found sanctuary from raiding Swazi warriors on this high mountain known by the Bantu as Mohuluhulu, "the great one". The flat summit formed a natural fortress of great strength which they were able to defend by rolling boulders down the cliffs. Although the Swazis attacked the fortress on numerous occasions they did so without success. In the words of Bulpin (1965) "The bones of their dead are still to be seen as mementoes of a tough siege and bitter defence".

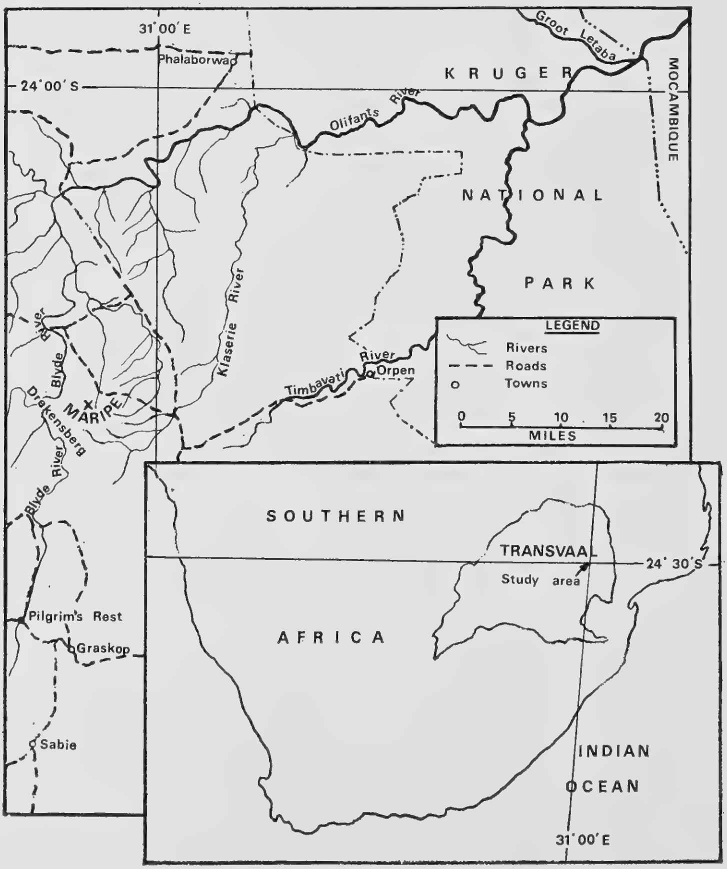

Fig. 1. — Location of Mariepskop, the study area.

The Mariepskop-Magalieskop complex is separated from the rest of the Drakensberg Range by a tributary of the Klaserie River and by the Blyde River, the latter forming a deep canyon. The Klaserie River, which rises in the rain forests on the southern slopes of Mariepskop, is a perennial stream that provides irrigation water for the riparian farmers in the Lowveld. Here, the Mariepskop complex marks the position where the Drakensberg escarpment changes direction, from a north-south direction to the south of Mariepskop to a south-easterly to north-westerly direction towards the Wolkberg. The valleys of the Klaserie and Blyde Rivers are important because they form migration routes for the Lowveld flora westwards into the mountains and for the montane flora eastwards to the Lowveld.

As at 31st March 1969, 2 954 ha of the Mariepskop Forest Reserve were covered by indigenous forest and 1 560 ha by plantations, while 121 ha are suitable for future plantations and 378 ha could not be utilized for silviculture.

Geology

According to Hall (1910) and Du Toit (1954), Mariepskop is partly formed of the erosion-resisting quartzites of the Black Reef Series that extends from Duiwelskantoor near Kaapsehoop to the Wolkberg. This formation outcrops along a narrow belt running roughly north and south, parallel to the Dolomite area on the west, and gradually turning towards the north-west after crossing the Blyde River. Between Belvedere and Mariepskop the Series attains its maximum surface width of 8.5 km.

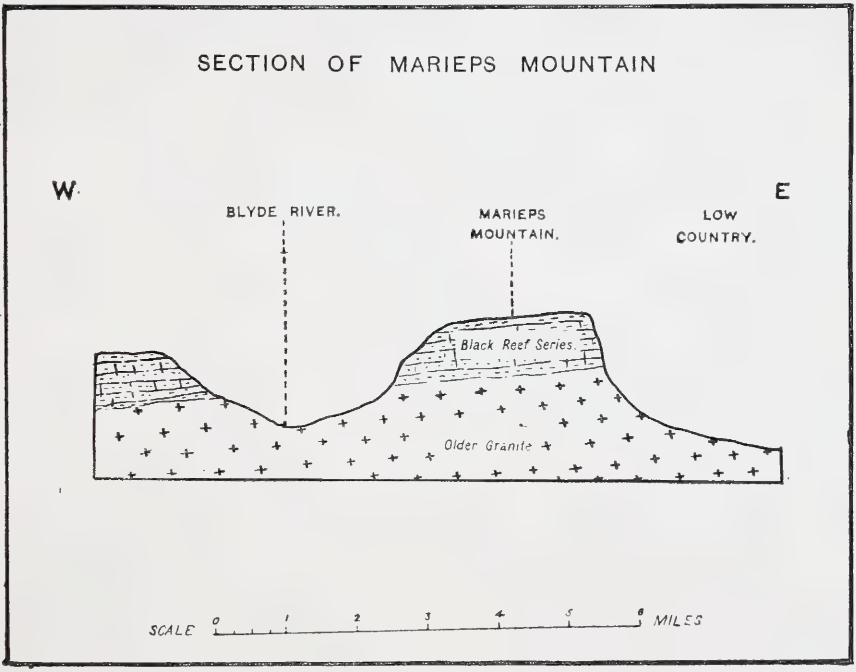

Fig. 2. — Geological section of Mariepskop Complex, (after Hall, 1910).

Northwards and north-westwards from the source of the Treur River, the Black Reef plateau undergoes a marked change, owing mainly to the increased erosion by the Treur, Blyde and Ohrigstad Rivers. These have cut deeply into the succession of quartzites and sandstones and have carved out a series of long, deep kloofs.

"The quartzites weather in the peculiar and fantastic manner of the Table Mountain Sandstone; are vertically jointed and give rise to scenery of considerable grandeur, the rugged grey crags of the Escarpment contrasting with the rounded, grassy, and often forested granitic slopes of the 'Low Veld' beneath" (Du Toit, 1954).

The Black Reef Series consists of a succession of sandstones, quartzites, conglomerates and sandy shales. This division of the Black Reef Series is clearly recognizable around Mariepskop. The major stratigraphical sub-divisions are:

780 m	Passage-beds	Shaly sandstones
	Upper quartzite group ...	Quartzite
	Middle shale group	Shales and shaly sandstones
	Lower quartzite group ...	Quartzite with conglomerate bands at base.

Soils

Most soils at Mariepskop belong to the Lateritic Red Earths of Van der Merwe (1940). The mature soils are strongly weathered and deep with the mineral content generally low. Horizon development is poor, but the soil is well drained. The soils of the higher areas with a higher rainfall are more leached and laterized than those in the Blyde River Canyon and at the foothills of the mountain. The humus content in the topsoil is fairly high.

No direct correlation could be found between the vegetation and soil type, except that both are influenced by the climate. For details of the soil conditions of Mariepskop Complex, see Table 1.

Table 1. — Soil conditions of Mariepskop Complex.

Soil depth		*Mountain Summit Grassveld*	*Montane Forest*	*Lowveld Sour Bushveld*
2.5-5 cm	pH	5.1	4.9	6.3
35 cm		5.0	4.4	5.4
2.5-5 cm	Texture	Coarse Sand	Loamy Sand	Coarse sandy loam
35 cm		Sand	Sandy loam	Sandy clay
2.5-5 cm	Structure	Structureless	Structureless	Poorly developed coarse block
35 cm		Structureless	Poorly developed coarse block	Moderately developed coarse block

Climate

The only data available on the climate of the area are those recorded at an intermediate altitude on the Mariepskop and Salique Forestry Stations. There is little doubt that the mean annual precipitation on the higher slopes is much higher than at these two stations, possibly up to 2 500 mm in the southern and south-eastern kloofs at higher altitudes, while it is probably much lower than the recorded rainfall along the foot-hills and in the Blyde River Valley. This presumption is borne out by the foresters at Mariepskop Forestry Station who have often witnessed rainy days and rainy periods higher up in the kloofs when it has been dry at the Forestry Station and near the Blyde River in the valley.

At the Mariepskop Forestry Station the mean annual rainfall over a period of 25 years is 13.7 mm and the average number of days per year on which rain falls is 96.2. The wettest months are December, January and February with monthly means of 205 mm, 244.6 mm and 286 mm, respectively, and an average of 12.7, 14.2 and 13.5 rainy days per month. The driest months are June, July and August with 2.4, 2.2 and 3.4 rainy days, respectively, and average precipitations of 23.4 mm, 19.1 mm and 20.8 mm per month. Heavy downpours of 50 mm and more within 24 hours are not unusual, and mist is frequent.

The Lowveld, nearly 1 220 m lower than the highest point on the mountain, is much warmer and the humidity much lower.

No temperature data are available.

Mist is an important source of moisture for most Bryophytic flora and the great number of epiphytes growing in the montane forests. The lichen *Usnea*, which is mainly dependent on mist for its moisture, is found on most of the forest trees, especially *Podocarpus latifolius, P. falcatus* and *Widdringtonia cupressoides*.

The Plant Communities

On the basis of observations made during the past ten years, the vegetation may be divided into several communities. No quantitative surveys have been carried out, however, and the subdivisions are based mainly upon physiognomic features.

1. Low Altitude Woodland Communities (Plate 1).

These plant communities are a continuation of Acocks' (1952) Lowveld Sour Bushveld and Van der Schijff's (1958) Large-leaved Deciduous Bushveld with Tall Grass. They occur in the Blyde River Valley, on the eastern foothills of the Drakensberg below the Forestry Station and on the western and northern slopes of Mariepskop.

At these sites the rainfall is relatively low, being from 635—760 mm per annum. The area is low-lying (altitude 760 m) and on the northern slopes, where the insolation is greater, the temperatures and the rate of evaporation are probably much higher than on the southern and south-eastern slopes.

The area is broken and the vegetation varies from relatively open bushveld with tall grass on the undulating hills and slopes, through dense brushwood and scrub in the dongas and dry ravines, to patches of submontane forest in sheltered kloofs. This vegetation type can be subdivided into four main communities.

PLATE 1. — The Mariepskop Complex as seen from the Lowveld near Acorn Hoek.

(a) *Lowveld Gallery Forest.*

This type of forest is found on the banks of the Blyde and the Klaserie Rivers, although it is not well developed along the Blyde River on the north-western side of Mariepskop. Prominent species include:-

Adina microcephala var. *galpinii*	*Ekebergia capensis*
Ficus capensis	*Combretum imberbe*
F. sycomorus	*Trichilia emetica*
Schotia brachypetala	*Catha edulis*
Spirostachys africanus	*Acacia robusta*
Syzygium cordatum	*A. ataxacantha*
S. guineense	*Bauhinia galpinii*
Combretum erythrophyllum	*Phoenix reclinata*
Acacia albida	*Bridelia micrantha*
Xanthocercis zambesiaca	*Acacia karroo*
Rauvolfia caffra	*Antidesma venosum*
Diospyros mespiliformis	

(b) *Savanna on mountain slopes* (Plate 2).

At higher altitudes, the slopes are wetter and more mesic tree and shrub species are found, e.g. *Faurea speciosa, F. saligna, Acacia ataxacantha, Greyia sutherlandii, Trema orientalis, Iboza riparia, Antidesma venosum, Ficus petersii, Heteropyxis natalensis, Fagara capensis, Catha edulis, Rhoicissus tridentata* and *Acacia caffra.*

On the drier lower slopes, trees and shrubs found, among others, are:-

Annona senegalensis
Pterocarpus angolensis
P. rotundifolius
Acacia caffra
Dichrostachys cinerea ssp. *glomerata*
Parinari curatellifolia ssp. *mobola*
Sclerocarya caffra
Grewia flavescens
G. monticola
Acacia gerrardii
A. sieberana var. *woodii*
A. davyi
Cussonia natalensis
Euclea divinorum
Commiphora mollis
Chaetacme aristata
Strychnos innocua
Aloe marlothii
Dombeya rotundifolia
Flacourtia indica
Ficus ingens
Lannea discolor
L. edulis
Pappea capensis
Peltophorum africanum
Ximenia caffra var. *natalensis*
Vangueria infausta
Ziziphus mucronata
Combretum zeyheri
C. apiculatum
C. imberbe
Holmskioldia tettensis
Ficus smutsii
F. soldanella
F. sonderi
Terminalia sericea
Trichilia emetica

PLATE 2. — Woodland on mountain slope with a north-eastern aspect, grading into submontane forest in a sheltered kloof in the foreground (right).

(c) *Savanna on rocky ridges and shallow soils.*

Typical trees and shrubs found in this type of habitat include the following:-

Kirkia wilmsii
Ptaeroxylon obliquum
Terminalia phanerophlebia
Steganotaenia araliacea
Urera tenax
Cussonia natalensis
Aloe marlothii
Combretum apiculatum
Grewia monticola
Ficus sonderi
Sarcostemma viminale
Euphorbia triangularis
E. tirucalli
Schotia brachypetala
Pappea capensis
Ficus ingens

(d) *Submontane forest in moist and sheltered kloofs.*

In moist kloofs higher up the mountain slopes and in the Blyde River Canyon itself, the vegetation changes into submontane forest. The following trees and shrubs are typical:-

Celtis africana
Ficus capensis
Ptaeroxylon obliquum
Ekebergia capensis
Mimusops zeyheri
Homalium dentatum
Syzygium cordatum
Anthocleista grandiflora
Halleria lucida
Pittosporum viridiflorum
Croton sylvaticus
Trimeria grandiflora
Cussonia spicata
Warburgia ugandensis
Protorhus longifolia
Acacia ataxacantha

PLATE 3. — High Mountain Grassland on plateau on mountain summit.

Lianas that can be expected in these forest patches include *Dalbergia armata, Rhoicissus tomentosa, R. tridentata, R. revoilii, Grewia occidentalis, Smilax kraussiana, Pterolobium exosum, Entada spicata* and *Acacia ataxacantha.*

In the kloofs of the eastern foot-hills these communities have mostly been replaced by plantations, but on the northern and western slopes the natural vegetation is still relatively intact.

2. High Mountain Grassland (Plate 3).

This type of vegetation is characteristic of the less moist and exposed ridges between wooded kloofs on the southern and south-eastern slopes, and also of the mountain summits of the Drakensberg. There are also isolated patches of mountain grassland scattered in the forest communities, a good example being in the vicinity of Colonel Reitz's grave. Frequently these patches of grassland serve as sponges for the mountain rivulets that constitute the head-waters of the Klaserie River.

Where the habitat is favourable, a fynbos type of vegetation replaces the grassveld. Hygrophilous species of shrubs and herbs associated with the grassveld in these areas include *Cliffortia linearifolia, Erica leucopelta* var. *luxurians, Hemizygia albiflora, Hypericum revolutum, Gunnera perpensa* and *Thelypteris palustris* var. *squamigera.*

The typical mesophytic mountain grassveld consists of a mixture of short, "sour" grasses of which some of the dominant species, such as *Danthonia drakensbergensis,* form tussocks. Characteristic grasses of this community are:-

Eragrostis sclerantha
E. caesia
E. capensis
Agrostis barbuligera var. *longipilosa*
Harpechloa falx
Loudetia simplex
Panicum spp.
Sporobolus eylesii
Themeda triandra
Stiburus alopecuroides
Trichopteryx dregeana
Andropogon distachyos
Eulalia villosa
Tristachya hispida

Geophytic species associated with the grassveld include:

Brunsvigia natalensis
Watsonia densiflora
Moraea spathulata
Dierama robustum
Hypoxis angustifolia
H. argentea
H. membranacea
H. rigidula

Other shrubs and herbs associated with the grassveld are:

Cliffortia linearifolia
Helichrysum lepidissimum
H. latifolium
H. wilmsii
H. odoratissimum
H. platypterum
H. appendiculatum
Erica leucopelta var. *luxurians*
E. drakensbergensis
Protea rouppelliae
P. rhodantha var. *rhodantha*
P. gaguedi
Lopholaena disticha
Mohria caffrorum
Smithia thymodora
Cheilanthes multifida
Vaccinium exul
Kniphofia triangularis ssp. *obtusiloba*
Restio sieberi var. *schoenoides*
Tetraria cuspidata
Scirpus macer
Vernonia corymbosa
Crotalaria doidgeae
Teedia lucida

A feature in this area is that some of the largest patches of mountain grassland have been replaced by pine plantations, while the small patches that remain higher up the mountain in the natural forest belt are gradually being invaded by *Pinus patula.* Every effort should be made to eradicate these self-sown trees from the sponges that provide the headwaters of the Klaserie River.

3. Mountain Plateau Communities.

The plateau (altitude 1 920 m) is bordered by vertical cliffs with a sheer drop of nearly 1 220 m. The surface of the plateau is extremely rocky with shallow soil and a very high, though fluctuating water table. The climate is moist and cool, although the effective rainfall is lower than in the kloofs. For most of the year strong winds, which impair tree growth, blow over the summit.

PLATE 4. — Sheltered rocky basin on summit of mountain with sclerophyllous scrub in the foreground and Widdringtonia scrub in the background.

The following three habitats can be distinguished on the plateau:

(a) Level, soil-covered areas occupied by *Danthonia* Grassland with associated geophytes. These areas are exposed to winds, the soil layer is approximately 0.5 m deep and there are no rock outcrops.

(b) Flat, exposed rock habitats without soil and covered by lichens.

(c) Sheltered rocky basins with shallow sandy soil where sclerophyllous shrubs occur (Plate 4).

PLATE 5. — Flat exposed lichen-covered rocks with fissures hundreds of feet deep on mountain summit. Wind-stunted **Podocarpus latifolius** scrub on right and stray **Pinus patula** in centre background.

The flat exposed rocks are covered with a variety of chasmophytic crustose and foliose lichens (Plate 5). Small hollows and depressions in the rock surface form semi-permanent pools of water where, under certain conditions, a very rich annual flora, with species such as *Ilysanthes conferta* and perennials such as *Isoëtes natalensis,* occurs.

Although wind is a determining factor for species composition and growth form, huge boulders surrounding shallow basins provide adequate shelter for local islands of luxuriant vegetation. In these shallow sheltered basins, heath-like shrubs and their associates are found, the following being either dominant or conspicuous:

Passerina montana	*Cliffortia serpyllifolia*
Erica leucopelta var. *ephebioides*	*C. nitidula* ssp. *pilosa*
E. leucopelta var *luxurians*	*Phylica paniculata*
E. woodii	*Psoraled pinnata*
Vaccinium exul	*Muraltia flanaganii*

In the same kind of habitat, and more often than not together with the fynbos, scattered communities of *Protea rouppelliae, P. rhodantha* var. *rhodantha* and *P. gaguedi* are found.

Other characteristic plants of the mountain plateau include:-

Anisopappus junodii	*Agapanthus inapertus*
Otiophora cupheoides	*Zaluzianskya katherinae*
Aloe nubigena	*Cineraria fruticetorum*
A. arborescens	*Crassula browniana*
Cyrtanthus huttonii	*C. setulosa*
Crocosmia pottsii	*C. parvisepala*
Clivia caulescens	*Kniphofia triangularis* ssp. *obtusiloba*
Anthospermum hispidulum	*K. linearifolia*
Eumorphia davyi	*Watsonia densiflora*
Hemizygia albiflora	*Euryops rogersii*
Silene burchellii	*Selago villosa*
Plectranthus fruticosus	*S. nelsonii*
Albuca fastigiata	*Nemesia melissaefolia*
Craterostigma wilmsii	*Macowania tenuifolia*
C. plantagineum	*Carex zuluensis*
Helichrysum spp.	*Monopsis kowynensis*
Sebaea erosa	*Hesperantha baurii*
Hebenstreitia comosa	*Lopholaena disticha*

4. *Widdringtonia* Communities (Plate 6).

These communities occur in fissures and kloofs on the southern and south-western cliffs just below the summit of the mountain, and between huge boulders on top of the mountain.

In the kloof south of the trigonometrical beacon on top of the mountain, where the habitat is probably particularly favourable for this community, practically pure stands of *Widdringtonia cupressoides* with trees up to 15 m were found. During 1967 this forest was, however, destroyed by a fire which was most probably caused by lightning. Fortunately the fire did not spread to the plateau vegetation or into the montane forest, probably because of the rocky surface of the areas adjoining this particular kloof. There are still few signs of life in the black scorched tree trunks of the *Widdringtonia* community and it appears that very few of the trees have survived the fire. The area is at present occupied by small herbs and shrubs, mainly *Selago* spp., *Psoralea* spp., *Helichrysum* spp., *Senecio* spp., *Hypericum* spp., *Dioscorea* spp., Cyperaceae and grasses. Cyperaceae occur throughout the area and, near the small stream that runs through the kloof, some species are approximately 1.25 m tall. Young *Widdringtonia* trees are appearing among the grass and, at present, average approximately 70 cm in height.

Between boulders on the mountain summit, where the vegetation is exposed to strong winds, the trees are often stunted. Here the *Widdringtonia* shrubs are associated with other shrubs and small trees such as *Rhus dura, Cliffortia nitidula, Podocarpus latifolius, Phylica paniculata, Cassine eucleaeformis, Pterocelastrus echinatus,* and with *Lycopodium clavatum* and *L. cernuum.*

On the slopes below the summit, *Widdringtonia cupressoides* occurs in association with various typical forest trees such as *Olea woodiana, Podocarpus latifolius, Xymalos monospora, Schrebera alata* and *Pterocelastrus echinatus.*

PLATE 6. — Destruction by fire of **Widdringtonia cupressoides** community in sheltered south-west facing kloof near summit of mountain.

5. Montane Forest (Plate 7).

A very large part of the Mariepskop-Magalieskop complex is covered with evergreen montane forest. In the deep kloofs and on the southern or south-eastern slopes, these forests attain their maximum development. In these kloofs the forest extends far down to merge eventually with the submontane forest of the Drakensberg foot-hills and this in turn into the Gallery Forest bordering the perennial rivers of the Lowveld.

Common tree species are:-

Podocarpus latifolius
P. falcatus
Diospyros whyteana
Ficus capensis
Kiggelaria africana
Faurea macnaughtonii
Pittosporum viridiflorum
Ilex mitis
Rapanea melanophloeos
Celtis africana
Halleria lucida
Apodytes dimidiata
Curtisia dentata
Calodendrum capense
Fagara davyi
Rhus chirindensis forma *legatii*
Olea capensis ssp. *macrocarpa*
Nuxia floribunda
Prunus africana

PLATE 7. — Transitional Lowveld Woodland—Montane Forest on sheltered east facing slopes of Mariepskop.

Where the forest attains its maximum development four strata can be distinguished:

(a) *Canopy*

The most common species of this stratum are:-

Podocarpus latifolius
P. falcatus (can attain a height of 18.5 m or more)
Cussonia umbellifera
Ochna oconnorii
Curtisia dentata
Kiggelaria africana
Nuxia floribunda
N. congesta
Apodytes dimidiata
Brachylaena discolor
Prunus africana
Combretum kraussii
Diospyros whyteana
Syzygium gerrardii
Schrebera alata
Faurea macnaughtonii
Brachylaena transvaalensis
Ficus petersii
Xymalos monospora
Celtis africana
Halleria lucida
Olea capensis ssp. *macrocarpa*
O. woodiana
Ilex mitis
Pterocelastrus echinatus
Bersama tysoniana
Trichocladus grandiflorus
Protorhus longifolia
Cussonia spicata
Cryptocarya liebertiana
C. woodii

PLATE 8. — Scrubby undergrowth in open patch of typical montane forest along Bedford footpath.

(b) *Shade-tolerant small-tree stratum*

In this stratum, trees and shrubs such as *Rawsonia lucida, Fagara davyi, Trimeria grandifolia, Rhus chirindensis* forma *legatii, Rothmannia capensis, Tricalysia capensis, Oxyanthus gerrardii, Grumilia capensis, G. kirkii, Calpurnia aurea* and *Croton sylvaticus*, are found.

(c) *Shrub stratum* (Plate 8)

This is a heterogeneous stratum that varies with the aspect and the amount of light that penetrates the two higher strata. It is best developed towards the forest margins, where it sometimes forms dense thickets. The most characteristic components are *Bowkeria cymosa, Sclerochiton haveyanus, Plectranthus* spp., *Piper capense, Mackaya bella, Pavetta lanceolata, Vangueria cyanescens, Duvernoia adhatodioides* and *Canthium obovatum.*

Along streams and in other moist places in dense shade, abundant growths of Pteridophyta are found, e.g. *Marattia fraxinea* var. *salicifolia, Blechnum capense* and *Cyathea capensis.*

In moist areas with higher light intensity, *Hypolepis sparsisora* is found, as well as *Adiantum poiretii, Asplenium friesiorum, A. gemmiferum* and *Blechnum attenuatum* var. *giganteum.*

(d) *Herb stratum*

Like the shrub stratum, the herb stratum on the forest floor varies appreciably with the light intensity and consists exclusively of herbs and herb-like species. Where the tree and shrub strata are very well developed and the light intensity is consequently low, the floor vegetation is in many cases totally wanting or limited to species such as *Carex spicato-paniculata, Galopina circaeoides, Clivia caulescens, Selaginella kraussiana* and *Oplismenus hirtellus.* The latter grass is able to grow in dense shade. Other species characteristic of this stratum include:

Impatiens sylvicola
I. duthieae
Cardamine africana
Pseudobromus africanus
Begonia spp.
Laportea peduncularis
Peperomia retusa
Hypoestes verticillaris
Streptocarpus micrantha
Thalictrum rhynchocarpum
Alchemilla rehmannii
Asplenium inaequalaterale
A. aethiopicum
A. erectum
A. rutaefolium
Dryopteris inaequalis
Thelypteris pozoi

Where there is more light the floor vegetation is fairly dense with *Plectranthus* spp., *Piper capense, Laportea alatipes* and representatives of the Acanthaceae like *Barleria gueinzii.*

(e) *Lianas*

A conspicuous feature of the montane forest is the variety of lianas and epiphytes. The most important lianas are:

Rhoicissus rhomboideus
R. revoilii
R. tomentosa
Jasminum abyssinicum
J. fluminense
Landolphia capensis

Canthium gueinzii
Secamone alpinii
S. gerrardii
Riocreuxia torulosa
Quisqualis parviflora (very robust)
Cnestis natalensis
Smilax kraussiana
Behnia reticulata
Stephania abyssinica
Helinus integrifolius

In some localities along the edge of the forest, *Rubus rigidus, Entada spicata, Sphedamnocarpus galphimiifolius, Dioscorea retusa, Senecio tamoides, S. quinquelobus* and *Mikania cordata* form an impenetrable thicket or scrub together with shrubs like *Hypericum revolutum, Pteridium aquilinum, Buddleia salvifolia* and *Plectranthus* spp. Lower down in the kloofs, where elements of the Lowveld flora become more prominent, the most conspicuous lianas are *Rhoicissus tridentata, Adenia gummifera, Dalbergia armata, Acacia ataxacantha* and *Pterolobium exosum.*

(f) *Epiphytes*

Most of the epiphytes recorded belong to the Pteridophyta or to the families Orchidaceae and Gesneriaceae of the higher plants. Epiphytic and epiphyllous mosses and lichens are also plentiful. The most important epiphytic Pteridophyta are:

Vittaria isoetifolia
Lycopodium verticillatum
L. dacrydioides
Polypodium polypodioides ssp. *ecklonii*
Pleopeltis macrocarpa
Loxogramme lanceolata
Asplenium sandersonii
A. anisophyllum
A. splendens
Elaphoglossum acrostichoides

The most common epiphytic orchids include:

Tridactyle tricuspus
Bulbophyllum sandersonii
Mystacidium capense
Angraecum sacciferum

Of the Gesneriaceae, *Streptocarpus haygarthii, S. micrantha* and *S. wilmsii* are common epiphytes, but they also grow, together with *Peperomia retusa,* on rocks in the forest.

Clivia caulescens (Amaryllidaceae), usually found on the forest floor, is often one of the most conspicuous epiphytes. Even *Aloe arborescens* is sometimes found as an epiphyte on trees at the edge of the forest.

6. Indigenous Communities in Plantations

In the *Pinus* plantations, especially the older ones, very few or no shrubs or herbs are found.

A better developed undergrowth is found in the *Eucalyptus* plantations. It would be interesting to observe the secondary succession in plantations left undisturbed for the next 20 or 30 years. In the higher areas with a southern or south-eastern aspect, it appears as though the succession will eventually result in a montane forest climax. Hitherto, the weeding that is done, is not selective, with the result that pioneer seedlings of the montane forest and of true forest trees are eliminated with normal ruderals.

Shrubs that have been found in the plantations include:

Clerodendrum glabrum	*Smilax kraussiana*
Vernonia shirensis	*Dombeya pulchra*
Hibiscus meeusei	*Heteropyxis natalensis*
Pycnostachys urticifolia	*Antidesma venosum*
Rhus intermedia	*Adenia gummifera*
Maesa lanceolata	*Cassia petersiana*
Trema orientalis	*Rhoicissus tridentata*
Lippia javanica	*Dalbergia armata*

The grass, *Setaria chevalieri*, is common, and the exotic liana, *Caesalpinia decapetala*, is encroaching on natural vegetation on the eastern foot-hills of Magalieskop.

The Affinities of the Flora

Of the considerable number of interesting species collected in the area, the following deserve special mention: the ferns, *Pyrrosia schimperiana* and *Hymenophyllum capillare*; the lichen, *Cladonia rangiformis*; and the fire lily, *Cyrtanthus huttonii*.

As far as can be ascertained, *Pyrrosia schimperiana* and *Hymenophyllum capillare* have not previously been collected in South Africa, and the only specimen of *Cladonia rangiformis* in the National Herbarium, Pretoria, is from the Congo. The distribution of *Cyrtanthus huttonii*, which is abundant underneath cliffs that face south and south-east on top of Mariepskop, requires further study. The nearest locality of this species to Mariepskop is the Katberg in the Eastern Cape Province. Phytogeographically, Mariepskop is of special importance, because it is clear that it is an unusually interesting floral area.

The presence of predominantly southern genera like *Protea, Erica, Otiophora, Phylica* and *Restio*, and species such as *Cliffortia nitidula, Passerina montana, Widdringtonia cupressoides, Myrsine africana, Vaccinium exul* and *Smithia thymodora* in the communities on the mountain plateau is of special interest as they also show affinities with the fynbos of the Chimanimani Mountains (Phipps and Goodier, 1962). This indicates that the eastern mountain ranges could possibly form a migration route for the sclerophyll flora of the South-western Cape. On the other hand, the montane forests have strong affinities with the forests of tropical eastern Africa, as found at Mount Salinda and the Chimanimani Mountains. Hence the Drakensberg Range forms a migration route for both the southern and the tropical elements of our indigenous flora.

Factors Endangering the Indigenous Flora

1. Silviculture

A very large area, 1 560 ha of the 5 013 ha incorporated in the Mariepskop Forest Reserve, is covered with plantations, of which an area of 1 152 ha is planted to conifers. Apart from the fact that very little undergrowth can survive under the coniferous trees, they are also very well adapted under these climatic conditions to encroach on the natural vegetation. Should these trees spread from the plantations in any great number, it would present a real danger to the Mountain Grassland. *Pinus patula*, in particular, establishes itself very easily at the forest edge and in grass patches. It is strongly urged that these trees should be destroyed as soon as they are noticed.

Encroachment on the indigenous flora is, however, not the only adverse influence of silviculture on the Mariepskop vegetation. The catchment area of the Klaserie River, which rises on the southern and south-eastern slopes of the Drakensberg, include 3 720 ha of plantations, comprising 794 ha at Mariepskop, 2 620 ha at Salique and 312 ha at Hebron.

It is already noticeable how springs, streams and rivulets, which flowed quite strongly about ten to fifteen years ago, have slowly become weaker, and how many of these have disappeared and completely dried up. It is of course possible that this phenomenon is due to purely natural causes.

Stream-flow measurements on the Klaserie River, where it is crossed by the main Tzaneen-Nelspruit road, are given in Table 2.

TABLE 2. — Mean annual rainfall for Mariepskop Forestry Station in millimetres compared with the mean annual run off for the Klaserie River in cubic metres between 1935 and 1960.

Period	*Rainfall (mm)*	*Run off (cubic metres)*
1935-40	1 729	143.07 x 10^6
1941-45	1 122	48.72 x 10^6
1946-50	1 332	38.43 x 10^6
1955-60	2 060	28.72 x 10^6
1961-64	1 308	16.58 x 10^6

It is interesting to see how the flow of the river has steadily decreased even though there has been no permanent drop in rainfall.

If the plantations have a detrimental effect on the subterranean water, the vegetation on the foot-hills of Mariepskop, as well as the riparian flora of the Lowveld, will be affected.

2. Fire

Occasional fires, detrimental to certain plant species, occur on the mountain, but fortunately it seems these are usually the result of natural causes. The last serious fire was that which destroyed the large pure community of *Widdringtonia cupressoides* in the gulley between the road and the trigonometrical beacon.

SUMMARY

The Mariepskop Complex lies in the Eastern Transvaal Drakensberg and forms part of the Eastern Escarpment which extends northwards from the Cape Province.

At the forestry station the mean annual rainfall is 1 369 mm, falling mainly in the summer months. In the sheltered kloofs facing east and south-east, precipitation, as judged by the vegetation, is probably much higher.

Mariepskop is geologically partly formed of the Black Reef Series. Soils are predominantly acid, lateritic, strongly weathered, and with generally low mineral content.

The natural vegetation is divided into five main communities, whereas indigenous shrubs and trees found in the pine plantations are dealt with separately.

Lowveld Sour Bushveld occurs in the Blyde River Valley on the eastern foot-hills of the Drakensberg below the Forestry Station and on the western and northern slopes of Mariepskop. The most conspicuous trees and shrubs are *Faurea saligna*, *F. speciosa*, *Peltophorum africanum*. *Sclerocarya caffra* and *Parinari curatellifolia* ssp. *mobola*, with typical Lowveld Gallery Forest on the river banks. Prominent riparian species include *Adina microcephala* var. *galpinii*, *Ficus capensis* and *Syzygium cordatum*.

High Mountain Grassland is characteristic of the less moist and exposed ridges between wooded kloofs on the southern and south-eastern slopes, and also of the plateau on the mountain summit. It is a short grassveld, the most conspicuous species being *Danthonia drakensbergensis*, *Loudetia simplex*, *Tristachya hispida* and *Andropogon distachyos*.

The communities of the mountain plateau show affinities with both the Cape fynbos and the scrub of the Chimanimani Mountains.

On the southern, south-eastern and south-western cliffs just below the summit of the mountain, in fissures and kloofs and between huge boulders on top of the mountain, pure *Widdringtonia cupressoides* scrub is found. Depending on the habitat, these communities vary from stunted shrubs to trees of appreciable size. One forest in a kloof south of the trigometrical beacon was destroyed by fire in 1967.

Evergreen montane forest with strong tropical affinities occurs in deep kloofs and in slopes facing south and south-east and is the most conspicuous component of the vegetation of this area. Typical species are *Podocarpus latifolius*, *P. falcatus*, *Diospyros whyteana*, *Kiggelaria africana*, *Nuxia floribunda*, *Faurea macnaughtonii* and *Ilex mitis*.

Factors endangering the indigenous flora are silviculture, fire and tourism.

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PRELIMINARY CHECK LIST OF THE VASCULAR PLANTS OF THE MARIEPSKOP AREA, SOUTH AFRICA

The Pteridophyta are arranged into families and genera according to Schelpe (1969) and the Angiospermae according to Dalla Torre and Harms (1900-1907) and Phillips (1951). The numbers following plant names represent the collector's numbers of the senior author.

PTERIDOPHYTA

Lycopodiaceae

Lycopodium carolinianum L. Moist habitat in sun 6450
L. cernuum L. Moist soil between rocks —
L. clavatum L. Open grassy slopes 4705
L. dacrydioides Bak. Epiphyte 6253
L. gnidioides L.f. On rocks 5586, 6307
L. ophioglossoides Lam. Epiphyte 1613
L. saururus Lam. Moist edge of Blyde River footpath 5092A
L. verticillatum L.f. Epiphyte on forest trees 4684, 6269

Selaginellaceae

Selaginella caffrorum (Milde) Hieron. On plateau near trigonemetrical beacon. Epiphyte on trees 6350
S. dregei (Presl) Hieron. Xerophyte on rocky outcrops 6349, 4819
S. kraussiana (Kunze) A.Br. Abundant on forest floor 4532, 4696
S. mittenii Bak. On rocky outcrop, Thalene-kop 6502

Equisetaceae

Equisetum ramosissimum Desf. Sand on Blyde River bank 6434

Ophioglossaceae

Ophioglossum reticulatum L. Pine plantation on Blyde River road 4515, 4302

Marattiaceae

Marattia fraxinea Sm. ex Gmel. var. *salicifolia* (Schrad.) C. Chr. Dense shade 5577, 4719

Osmundaceae

Osmunda regalis L. In water and on bank of river 5137
Todea barbara (L.) Moore. Dense shade along streams 4924

Schizaeaceae

Anemia dregeana Kunze. Terrestrial, in dry bush 4513, 5049
Mohria caffrorum (L.) Desv. Grassveld on mountain 5129, 4447
Schizaea pectinata (L.) Sw. Summit of mountain, between rocks 2478

Gleicheniaceae

Gleichenia polypodioides (L.) Sm. Shade of boulders 4490, 4538
Dicranopteris linearis (Burm.) Underw. Moist open areas 4649, 5088

Hymenophyllaceae

Hymenophyllum capense Schrad. Very moist places 6264, 6314
H. capillare Desv. On overhanging cliffs 4872, 4301
H. polyanthos Sw. var *kuhnii* (C. Chr.) Schelpe. Shady places, on stems of trees 4300
H. tunbridgense (L.) Sm. Epiphyte, in dense shade 4624, 5825
Trichomanes pyxidiferum L. var. *melanotrichum* (Schlechtd.) Schelpe. Epiphyte on stems of forest trees 4722, 5216
T. rigidum Sw. Edge of stream 1604, 1606

Cyatheaceae

Cyathea dregei Kunze. Moist open areas 5900
C. capensis (L.f.) Smith. Moist deep shade, southern kloofs 4306, 4720

Dennstaedtiaceae

Hypolepis sparsisora (Schrad.) Kuhn. Moist sunny places in forest 4718, 5063
Pteridium aquilinum (L.) Kuhn. Widespread weed on forest margins and moist areas 5487
Blotiella glabra (Bory) Tryon. Moist open areas in forest 5574, 4717
Histiopteris incisa (Thunb.) J. Sm. Terrestrial on damp soil ...... —

Vittariaceae

Vittaria isoetifolia Bory. Epiphyte in mountain forest 4939, 6024

Adiantaceae

Pityrogramma argentea (Willd.) Domin. Between rocks on damp soil 5595, 4489
Adiantum aethiopicum L. Shaded areas near water ...... —
A.capillus-veneris L. Shaded areas near water 5486
A. poiretii Wikstr. Open areas in forest 4981
Pteris buchananii Bak. ex Sim. Klaserie Drift on edge of forest 4936
P. catoptera Kunze. Moist places in forest margin 4467, 4996
P. dentata Forsk. ssp. *flabellata* (Thunb.) Runem. Kloof on western bank of Klaserie River 5488
P. vittata L. Kloof on western bank of Klaserie River 5484
Cheilanthes eckloniana Kunze. Open grassy areas, NE facing 4960, 4973
C. hirta Sw. North-eastern slopes in grassveld 5560
C. multifida Sw. Shade of boulders 5621, 4623
Doryopteris concolor (Langsd. & Fisch.) Kuhn var. *kirkii* (Hook.) Fries. Dry banks of donga 5048
Pellaea calomelanos (Sw.) Link. Between rocks, relatively dry areas 5152, 4932
P. goudotii (Kunze) C. Chr. Rocky outcrops 6053, 5135
P. quadripinnata (Forsk.) Prantl. Grass patches 5108
P. viridis (Forsk.) Prantl. Grassveld on north-eastern facing slopes 5094, 4934
P. viridis (Forsk.) Prantl var. *glauca* Sim. Open areas, between rocks 6455, 5514

Polypodiaceae

Pyrrosia schimperiana (Mett.) Alston. Rock crevices on cliffs 5505
Loxogramme lanceolata (Sw.) Presl. Epiphyte 5545
Polypodium polypodioides (L.) Hitch. ssp. *ecklonii* (Kunze) Schelpe. Epiphyte 5547, 4949
Pleopeltis excavata (Bory ex Willd.) Sledge. Between rocks at high altitudes 4879, 4762
P. macrocarpa (Willd.) Kaulf. Epiphyte in mountain forest 5546, 5580
P. schraderi (Mett.) Tard. On boles of large forest trees 5903

Davalliaceae

Oleandra distenta Kunze. Rocky outcrops 5901

Aspleniaceae

Asplenium aethiopicum (Burm.) Becherer. Forest floor 4327A, 5159
A. anisophyllum Kunze. Epiphyte in forest 5107, 5543
A. erectum Bory ex Willd. Rocks on forest floor 4700
A. friesiorum C.Chr. Moist areas in forest 4789, 5160
A. gemmiferum Schrad. Dense shade in forest 5575
A. inaequaelaterale Hieron. Forest floor 4724
A. rutaefolium (Berg.) Kunze. Rocky places of forest floor 4682
A. sandersonii Hook. Epiphyte 5548, 4952
A. splendens Kunze. Epiphyte 4955, 5047
A. theciferum (H.B.K.) Mett. var. *concinnum* (Schrad.) Schelpe. Epiphyte 1627
Ceterach cordatum (Thunb.) Desv. Rock crevices in shade 5339

Thelypteridaceae

Thelypteris bergiana (Schlechtd.) Ching. Terrestrial in forest ...... —
T. dentata (Forsk.) E. St. John. Kloof on western bank of Blyde River 5485
T. palustris Schott var. *squamigera* (Schlechtd.) Tard. Waterlogged grassveld near Reitz's grave 5064
T. pozoi (Lagasca) Morton. Forest floor 5110, 5095
T. gueinziana (Mett.) Schelpe. Small stream on way to Klaserie Waterfall 5046

Athyriaceae

Cystopteris fragilis (L.) Bernh. In thick bush near running water 1615
Athyrium scandicinum (Willd.) Presl. Moist ground, on forest margin 4706, 4937

Lomariopsidaceae

Elaphoglossum acrostichoides (Hook.) Schelpe. Near waterfall, rocks in forest 5904
E. angustatum (Schrad.) Hieron. Rocks near waterfall 5902, 4928
E. aubertii (Desv.) Moore. Epiphyte on rocks 1618
E. macropodium (Fée) Moore. Among rocks at waterfall 1630
E. lastii (Bak.) C. Chr. Rocky outcrops 6619, 4927

Aspidiaceae

Dryopteris inaequalis (Schlechtd.) O. Kuntze. Forest floor 4449, 5558
Rumohra adiantiformis (Forst.) Ching. Rocky outcrops in open areas in forest 4779

Blechnaceae

Blechnum attenuatum (Sw.) Mett. var. *giganteum* Bonap. Edge of footpath in forest 5092
B. capense (L.) Schlechtd. Moist areas 4790, 4500
B. punctulatum Sw. Moist banks of river 5477, 5132
B. punctulatum Sw. var. *atherstonei* (Pappe & Rawson) Sim. Moist places 4929
B. tabulare (Thunb.) Kuhn. Edge of river 5109

GYMNOSPERMAE

Podocarpaceae

Podocarpus falcatus (Thunb.) R. Br. ex Mirb. Canopy tree in montane forest 6015, 4404
P. latifolius (Thunb.) R. Br. ex Mirb. Canopy tree in montane forest 5841, 4688

Cupressaceae

Widdringtonia cupressoides (L.) Endl. Tree or large shrub on mountain 5842, 4477

ANGIOSPERMAE

Monocotyledoneae

Typhaceae

Typha latifolia L. ssp. *capensis* Rohrb. Swampy environment and streams 356

Gramineae

Imperata cylindrica (L.) Beauv. Moist areas —
Eulalia villosa (Thunb.) Nees. Eastern slopes of Magalieskop 5889, 4661
Microstegium capense (Hochst.) A. Camus. Forest floor 4416
Ischaemum arcuatum (Nees) Stapf. Blyde picnic spot 6425
Urelytrum squarrosum Hack. Eastern slopes —
Hemarthria altissima (Poir.) Stapf & C. E. Hubb. Localized in moist places —
Rottboellia exaltata L.f. Eastern slopes of mountain 6059
Trachypogon spicatus (L.f.) Kuntze. Mountain grassveld 6342
Andropogon amplectens Nees. Infrequent in grassveld —
A. distachyos L. North-eastern slopes of mountain 5583
A. eucomus Nees. Side of road in pine plantation 4473
A. lacunosus J. G. Anders. Mountain grassveld 5992
A. schirensis Hochst. var *angustifolius* Stapf. Tall grassveld on foothills of mountain 6151
Bothriochloa insculpta (Hochst.) A. Camus. Near Blyde River picnic spot 6125
Schizachyrium semiberbe Nees. Eastern slopes of mountain —
Cymbopogon excavatus (Hochst.) Stapf. Tall grassveld on foothills of mountain —
C. plurinodis Stapf ex Burtt Davy. Tall grassveld on foothills of mountain —
C. validus Stapf ex Burtt Davy. Foothills of mountain, tall grassveld 6144, 6150
Hyparrhenia dichroa Stapf. Banks of Blyde River 6426
H. hirta (L.) Stapf. Tall grassveld on foothills of mountain —
H. tamba Anderss. Bedford footpath, tall grassveld, north-eastern slopes 5562
Monocymbium ceresiiforme (Nees) Stapf. Mountain grassveld —
Heteropogon contortus (L.) Beauv. Mountain grassveld —
Hyperthelia dissoluta (Nees) Clayton. Tall grassveld on foothills of mountain —
Cleistachne sorghoides Benth. Lower slopes of mountain in pine plantation 4571
Themeda triandra Forsk. Mountain grassveld 5989, 4786
Tragus berteronianus Schult. Small annual. Very localized on fallows —
Perotis patens Gand. Small grass, common in disturbed areas 6071
Paspalum commersonii Lam. Banks of Blyde River 6424, 5994
P. dilatatum Poir. Banks of Blyde River 6410

P. urvillei Steud.	Locally along road on lower slopes	—
Panicum deustum Thunb.	Blyde River picnic spot	6102, 6464
P. ecklonii Nees.	Mountain grassveld	6498, 4830
P. filiculme Hack.	Roadside between forest station and Klaserie Waterfall	5467
P. maximum Jacq.	Pine plantations on lower slopes	6148, 6406
P. monticolum Hook.f.	Klaserie Drift, in moist places	6301
P. natalense Hochst.	Scarce in mountain grassveld	6487, 6047
P. repens L.	Sandbanks at Blyde picnic spot	6430
Alloteropsis semialata (R. Br.) Hitchc.	Tall grassveld on foothills of mountain	6152
Brachiaria brizantha (Hochst. ex A. Rich.) Stapf.	Lower slopes of mountain	—
B. serrata (Thunb.) Stapf.	Along roadside	—
Digitaria eriantha Steud.	Mountain grassveld	—
D. ternata (Hochst.) Stapf.	In pine plantations on lower slopes	4568
D. zeyheri (Nees) Henr.	Lower slopes of mountain, on roadside	6062
Rhynchelytrum repens (Willd.) C. E. Hubb.	Scattered on rocky places in mountain grassveld	6468, 4384
R. rhodesianum (Rendle) Stapf & C. E. Hubb.	Bedford footpath on north-eastern slope of mountain	5570
R. setifolium (Stapf) Chiov.	Mountain grassveld	6457, 5985
Oplismenus hirtellus (L.) Beauv.	Forest floor	6153, 4325A
Setaria chevalieri Stapf ex Stapf & C. E. Hubb.	Banks of Blyde River	6407, 5956
S. flabellata Stapf.	In vlei near Reitz's grave	5984
S. lindenbergiana (Nees) Stapf.	Shade of trees near Blyde picnic spot	6108
S. sphacelata (Schum.) Stapf & C. E. Hubb. ssp. *nodosa* de Wit.	Open patch in forest	4915
Pennisetum macrourum Trin.	Mountain grassveld	6035
Prosphytochloa prehensilis (Nees) Schweick.	Forest margin	6289, 6270A
Leersia hexandra Swartz.	Moist habitat on lower slopes	—
Ehrharta erecta Lam.	Small grass in shade of trees	6030
Aristida congesta Roem. & Schult. ssp. *barbicollis* (Trin. & Rupr.) de Wint.	Rare pioneer grass of disturbed grassveld	—
Pseudobromus africanus (Hack.) Stapf.	Fringe on high forest	4406
Sporobolus africanus (Poir.) Robyns & Tournay.	Common in disturbed areas	—
S. centrifugus Nees.	Mountain grassveld	5986
S. eylesii Stent & Rattray.	Mountain grassveld	5060
S. pyramidalis Beauv.	Blyde River Canyon	6118, 5864
Agrostis barbuligera Stapf var. *longipilosa* Goossens & Papendorf.	Mountain grassveld	4776
A. lachnantha Nees.	Mountain grassveld	4868, 6270
Tristachya hispida (L.f.) K. Schum.	Foothills of mountain, tall grassveld, south-eastern slopes	5874
Trichopteryx dregeana Nees.	Mountain grassveld near Reitz's grave	6029, 4471
Loudetia flavida (Stapf) C. E. Hubb.	Mountain grassveld	6486
L. simplex (Nees) C. E. Hubb.	Mountain grassveld	5981, 5062
Danthonia drakensbergensis Schweick.	Common grass on mountain summit	5832, 4844
D. macowanii Stapf.	Between boulders on summit of mountain	6003
Pentaschistis natalensis Stapf.	Mountain grassveld	5077
Danthoniopsis pruinosa C. E. Hubb.	Rock crevices near Blyde River picnic spot	6092, 6392
Styppeiochloa gynoglossa (Goossens) de Wint.	Small grass on plateau	6344
Rendlia altera (Rendle) Chiov.	Mountain sourveld	6329
Cynodon dactylon (L.) Pers.	Pioneer on the bare disturbed areas	—
Harpechloa falx (L.) Kuntze.	Mountain sour grassveld	5989A, 5990
Chloris virgata Swartz.	Disturbed areas and sandbanks of dry riverbeds	—
Eustachys paspaloides (Vahl) Lanza & Mattei.	Locally abundant in *Combretum* veld in Lowveld	—
Eleusine africana Kennedy-O'Byrne.	Widespread ruderal and weed of cultivation and disturbance	—
Phragmites australis (Cav.) Trin. ex Steud.	Along Klaserie River	—
Pogonarthria squarrosa (Licht.) Pilg.	Tufted grass on disturbed areas	—
Eragrostis acraea de Wint.	High mountain sour grassveld	6343
E. atrovirens (Desf.) Trin.	Blyde River canyon, small grass on riverbanks	6117
E. caesia Stapf.	Mountain grassveld, tufted grass on mountain summit	6004
E. capensis (Thunb.) Trin.	Short grass, mountain sour grassveld	6469
E. curvula (Schrad.) Nees.	Variable grass, in sand in dry river bed, Blyde River Canyon	6090
E. racemosa (Thunb.) Steud.	Short grass mountain sour grassveld	6438
E. sclerantha Nees.	Edge of forest	4470
E. superba Peyr.	Rare in grassveld	—

Koeleria cristata (L.) Pers. Small tufted grass on rocky outcrops in grassveld 6034
Stiburus alopecuroides (Hack.) Stapf. Mountain grassveld 5468, 5993
Brachypodium flexum Nees. Along forest margin 4354

Cyperaceae

Lipocarpha senegalensis (Lam.) T. & H. Dur. Moist sandbanks 6435
Cyperus albostriatus Schrad. Forest floor 4344, 4530
C. distans L.f. Lower slopes of mountain 6305
C. fastigiatus Rottb. Lower slopes of mountain on riverbank 6282
C. longus L. At roadside on mountain plateau 4857
C. obtusiflorus Vahl. Common in grassveld on lower eastern slopes 5861
C. rupestris Kunth. Grassveld on mountain plateau 6490
C. textilis Thunb. Riverbank at Blyde picnic spot 6409
Pycreus polystachyus Beauv. Riverbank at Blyde picnic spot 6427
Mariscus congestus C.B. Cl. Mountain grassveld, moist habitat 4772, 5079
M. sp. cf. *M. sieberianus* Nees. Summit of mountain 6011
Kyllinga alba Nees var. *alata* C.B. Cl. Grassveld 5912
K. cylindrica Nees. Mountain grassveld 5977, 6443
K. sp. Mountain grassveld 4946
Ficinia filiformis Schrad. Mountain plateau, between rocks 5607, 6002
F. gracilis Schrad. Moist places on mountain plateau 4842, 4892
F. stolonifera Boeck. Between rocks on mountain plateau 4891
Fuirena chlorocarpha Ridl. Riverbank at Blyde picnic spot 6408
Scirpus falsus C.B. Cl. Between rocks on mountain plateau 6186
S. fluitans L. Hydrophyte in pool in mountain sour grassveld 4774, 4353
S. inclinatus (Del.) Aschers. & Schweinf. Moist riverbank at Blyde picnic spot 6428
S. macer Boeck. Mountain grassveld 5604
S. sp. Shrub in running water 6310
Fimbristylis hispidula (Vahl) Kunth. In waterlogged vlei in mountain forest 5472
Tetraria cuspidata C.B. Cl. Mountain grassveld 5609
Scleria natalensis C.B. Cl. In vlei near picnic spot 6384
Schoenoxiphium schweickerdtii Merxm. Between large boulders on summit of mountains 6005
S. sp. On banks of Klaserie River at waterfall 5136
Kobresia lancea (Thunb.) Kük. Mountain sour grassveld 6240
Carex spicato-paniculata C.B. Cl. Herb on forest floor 4345, 4591
C. sp. cf. *C. zuluensis* C.B. Cl. Sedge common on summit of mountain 4843

Palmae

Phoenix reclinata Jacq. Widely distributed on riverbanks. Blyde picnic spot 6433

Araceae

Zantedeschia tropicalis (N.E. Br.) C. Letty. Scattered in grassveld, scrub forest and plantations 4797, 6515
Stylochiton natalensis Schott. Common in plantations 5857
S. sp. In forest, disturbed area 6540

Restionaceae

Restio sieberi Kunth var. *schoenoides* Pillans. Grassveld on summit of mountain 5610, 5837

Xyridaceae

Xyris umbilonis A. Nilss. Klaserie River on road to waterfall 5913

Commelinaceae

Commelina africana L. Herb of grassveld and earlier seral and subseral stages 4356, 4909
C. benghalensis L. Herb of grassveld and earlier seral and subseral stages 4582, 4910
C. ekloniana Kunth. Mountain forest 6018
Aneilema aequinoctiale Kunth. Trailing to scrambling herbaceous plant of undergrowth, in plantation 4583, 6058
Cyanotis lapidosus Phill. Between rocks and stones on slopes 4763
C. speciosa (L.f.) Hank. Infrequently on undisturbed areas 6466

Juncaceae

Juncus lomatophyllus Spreng. Riverbed near Klaserie Waterfall 6266, 6306
J. punctorius L.f. Riverbank, Blyde picnic spot 6429
J. sp. In vlei on way to waterfall 5471

Liliaceae

Gloriosa superba L. Widespread in well-protected areas of scrub forest ...... —
Littonia modesta Hook. Small herbaceous scrambler in scrub and scrub forest 4552
Bulbine trichophylla Bak. Herb with yellow flowers in mountain grassveld 5849, 6335
Anthericum angulicaule Bak. Herb on summit of mountain 5838
A. fasciculatum Bak. Between rocks on mountain slope 6334
Chlorophytum bokweri Bak. Scattered to locally gregarious 5920
C. comosum (Thunb.) Jacques. Geophytic herb on summit of mountain 4906
Eriospermum cooperi Bak. Widespread geophytic herb, often in disturbed areas 6493
Kniphofia triangularis Kunth ssp. *obtusiloba* (Diels) Codd. Summit of mountain 4518, 6524
K. linearifolia Bak. In pine plantation and mountain grassveld 5111, 4618
Aloe affinis Berger. Eastern slope of mountain between stones 5559, 6215
A. arborescens Mill. Widespread shrubby species on rocky areas ...... —
A. marlothii Berger. Widespread in warmer Lowveld 6261A
A. nubigena Groenewald. Mountain summit, common in rock crevices 4890, 4930
A. sessiliflora Pole Evans. Rocky hills and summit ...... —
A. sp. Disturbed area, northern slopes of mountain grassveld 6257
Agapanthus inapertus Beauv. Perennial herb on summit of mountain 4520
Albuca fastigiata (L.f.) Dryand. Rocky areas on mountain summit 4519
A. melleri Bak. Summit of mountain ...... —
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Dipcadi viride (L.) Moench. Open grassveld near forest station 4944
Scilla cooperi Hook.f. Rocky situations in open spaces in mountain forest 6363
S. glaucescens F. Z. v.d. Merwe. Lower western slope of mountain 3681
S. natalensis Planch. On cliffs on eastern highland 6172
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Eucomis pole-evansii N.E. Br. Edge of forest in shrubby grassveld on northern slopes 4689
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Ornithogalum inandense Bak. Marshy grassveld 6244
O. setifolium Kunth. Rock crevices 6331
Dracaena hookeriana K. Koch. In kloof below forest station ...... —
Sansevieria sp. Locally common in Lowveld ...... —
Asparagus asparagoides (L.) Wight. Woody liane on forest margin 4784
A. crispus Lam. Between rocks on mountain summit 4854
A. falcatus L. In scrubby and gallery forest ...... —
A. scandens Thunb. In ravines 6333
A. setaceus (Kunth) Jessop. Undergrowth of scrubby forest 4698, 6296
A. subulatus Thunb. Between rocks on mountain summit 4622
Behnia reticulata (Thunb.) Didr. In forest, scrub forest and gallery forest 4548, 4276A
Smilax kraussiana Meisn. In scrub forest, gallery forest and savanna woodland 4507

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Haemanthus magnificus Herb. Moist shady places, widespread 6256
Clivia caulescens Dyer. Epiphyte or on forest floor 4862
Brunsvigia sp. cf. *B. natalensis.* Plateau in grassveld 6355
Crinum macowanii Bak. Mountain slope at forest station 5071, 5855
Cyrtanthus huttonii Bak. Eastern slope of mountain 4564
Hypoxis angustifolia Lam. Small grasslike plant, scattered through seral grassveld 4535, 6321
H. argentea Harv. ex Bak. Scattered in disturbed areas 4679
H. membranacea Bak. Moist places 4818
H. rigidula Bak. Herb of seral grassveld 5891, 6379
H. sp. Near Klaserie Waterfall on side of road 5908

Velloziaceae

Vellozia talbotii Balf. Rocks at waterfall 4363, 4505

Dioscoreaceae

Dioscorea cotinifolia Kunth. Forest margin on lower slopes of mountain 4748, 5932
D. dregeana Bak. var. *hutchinsonii* Burkill. Drier slopes of mountain and low lying areas 5942
D. sylvatica Eckl. Scrub forest and forest margins 4846, 6295
D. retusa Mast. Scrub forest and forest margins 4502, 4897

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Moraea spathulata (L.f.) Klatt. Grassveld on mountain slopes 4553, 6325
Dietes vegeta (L.) N.E. Br. Undergrowth on side of roads and forest margins 4878, 6360
Aristea ecklonii Bak. Moist open places, undergrowth in forest 4701, 6265
A. sp. cf. *A. ecklonii* Bak. Forest floor 5847, 5926
A. woodii N.E. Br. Mountain grassveld 4972, 5980
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Dierama robustum N.E. Br. Grassveld on summit of mountain 6635A
Crocosmia aurea Planch. Geophytic herb of lightly shaded moist places ...... —
C. pottsii (Bak.) N.E. Br. Herb on riverbank near waterfall 5973
Gladiolus papilio Hook.f. Geophytic herb of marshy places 4508, 6032
G. psittacinus Hook., sens. lat. Infrequent to localized geophytic herb of grassveld 4945
Lapeirousia grandiflora Bak. Small perennial herb of grassveld and scrubby vegetation 4945
L. laxa (Thunb.) N.E. Br. Herb on fringe of forest 5969
Watsonia densiflora Bak. Grassveld, on mountain summit 4526

Zingiberaceae

Kaempferia aethiopica (Schweinf.) Solms-Laub. Widespread in shade of large trees on lower slopes of mountains 5869

Orchidaceae

Stenoglottis fimbriata Lindl. On rocky outcrops on south-western slopes 5161
Habenaria sp. Ground orchid in sheltered areas on lower slopes ...... —
Satyrium cristatum Sond. Ground orchid between rocks 6323, 4974
Disa saxicola Schltr. In humic pocket on summit of mountain 4824, 6316
Polystachya ottoniana Reichb.f. Epiphyte on forest trees 4788, 6357
P. transvaalensis Schltr. Epiphyte on forest trees 6364, 6496
Ansellia gigantea Reichb.f. Large tufted epiphyte on Lowveld trees in Blyde Canyon —
Eulophia angolensis (Reichb.f.) Summerh. Ground orchid in pine plantations in lower areas 6536
E. ensata Lindl. Ground orchid in grassveld on lower slopes 6497
E. petersii Reichb.f. In tall mountain-gassveld 4516
E. speciosa (R. Br. ex Lindl.) H. Bol. Ground orchid in pine plantation 5821
Bulbophyllum sandersonii Reichb.f. Epiphyte on forest trees 4680, 6297
Angraecum conchiferum Lindl. Epiphyte on forest trees 6446
A. sacciferum Lindl. Epiphyte in indigenous forest 4685
Tridactyle tricuspis (H. Bol.) Schltr. Epiphyte on large trees 4386
Cyrtorchis praetermissa Summerh. Epiphyte in forest trees 6539
Mystacidium capense (L.f.) Schltr. Epiphyte on stems of trees 4387, 5170

Dicotyledoneae

Piperaceae

Piper capense L.f. Soft shrub of moist shady kloofs in high forest 4729
Peperomia arabica Decne. In shade of large trees on mountain slopes 5483, 6085
P. retusa (L.f.) A. Dietr. Herb on forest floor 4993

Salicaceae

Salix woodii Seemen. Small tree in streams on lower mountain slopes 4750

Myricaceae

Myrica pilulifera Rendle. Small tree on forest margin in open areas 5566, 6169
M. serrata Lam. Small tree on riverbank in Blyde River Canyon 6432

Ulmaceae

Celtis africana Burm.f. Tall tree, infrequently scattered in scrub forest, high forest and forest margins 4738
Trema orientalis (L.) Blume. Small to medium-sized tree in gallery forest on lower slopes 4539, 4734

Moraceae

Ficus capensis Thunb. Gallery forest in Lowveld 5054
F. craterostoma Warb. ex Mildbr. & Burret. Strangler in high forest 6133, 6214
F. ingens (Miq.) Miq. Small to fair-sized tree on rocky outcrops, on lower slopes —
F. petersii Warb. Strangler, fairly common 4549, 4715
F. sonderi Miq. Tree, common on hills ...... —
F. sycomorus L. Gallery forest, Lowveld ...... —
Cannabis sativa L. At Klaserie Waterfall 6365

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Urera tenax N.E. Br. Rocky places on north-eastern slopes 4985
Laportea alatipes Hook.f. Common in open areas on forest floor 5091
L. peduncularis (Wedd.) Chew. Rocky areas in kloofs on lower slopes 6134, 4531
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Proteaceae

Faurea galpinii Phill. On Bedford footpath on northern slopes of mountain 6248, 4988
F. macnaughtonii Phill. Large tree in rain forest near waterfall 4350
F. saligna Harv. Small to medium sized tree. In scrub and climax savanna woodland 4795, 6080
F. speciosa Welw. Small tree on edge of forest 4984, 6447
Protea gaguedi J. F. Gmel. Small tree in grass patches on maintain 4998, 6483
P. parvula Beard. Mountain grassveld, near waterfall 6311
P. rhodantha Hook.f. var. *falcata* Beard. Small tree in mountain grassveld near water 5924
P. rhodantha Hook.f. var. *rhodantha.* Small tree, in mountain grassveld 4534, 6484
P. rouppelliae Meisn. Tree on mountain cliff 4533, 6482

Loranthaceae

Loranthus dregei Eckl. & Zeyh. In Blyde River Lowveld 5144
L. minor (Harv.) Sprague. Parasite on bushveld trees 5941, 6076
L. zeyheri Harv. Parasite on western slopes of mountain 5943
Viscum nervosum Hochst. ex A. Rich. Parasite on trees on fringe of forest 4760, 6251
V. obscurum Thunb. Parasite on forest trees 4643, 5143

Olacaceae

Ximenia caffra Sond. var. *natalensis* Sond. Shrub in pine plantation 6505

Polygonaceae

Rumex crispus L. Near nursery on road to picnic spot 6140
R. sagittatus Thunb. On side of road to Blyde picnic spot 4607
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P. salicifolium Brouss. Near Klaserie Waterfall in marsh 4459, 5020

Amaranthaceae

Cyathula cylindrica Moq. Herb in grassveld on western slopes 4596, 5155
Pupalia lappacea (L.) Juss. In shade of scrub on western slopes 5521
Achyranthes sicula (L.) All. On Blyde River bank in scrub 5510

Nyctaginaceae

Commicarpus pentandrus (Burch.) Heim. Herb on banks of Blyde River 5522, 5951

Phytolaccaceae

Psammotropha myriantha Sond. In grassveld on summit of mountain 5619, 5839
Phytolacca octandra L. Exotic small shrub in disturbed areas on lower slopes 4346

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Knowltonia sp. In grassveld ...... —
Clematis brachiata Thunb. Widespread liane in seral and climax communities 4586, 5168
Thalictrum rhynchocarpum Dill. & Rich. Wet shady cool sites in high forest 4702

Menispermaceae

Cocculus hirsutus (L.) Diels. Kloofs in high forest ...... -
Stephania abyssinica (Dill & Rich.) Walp. var. *tomentella (Oliv.) Diels. Early* scrubby seral stages and high forest margins 4671, 4635
Cissampelos torulosa E. Mey. ex Harv. Twiner on forest margins 4672

Annonaceae

Annona senegalensis Pers. Small tree in scrub and young pine plantations 6261, 6401

Monimiaceae

Xymalos monospora (Harv.) Baill. Tall tree in mountain forest 4497, 4631

Lauraceae

Ocotea viridis Kosterm. Very scarce in high forest ...... —
Cryptocarya liebertiana Engl. High forest tree of canopy and margin 6107A
C. woodii Engl. Tall tree in forest 6107
Cassytha filiformis L. Parasite on shrubs in riverbeds 5113

Cruciferae

Heliophila rigidiuscula Sond. Herb between grass 6465
Cardamine africana L. Herb on bare patches and rocky areas on forest floor 6267, 4716

Capparidaceae

Capparis tomentosa Lam. Shrub, common on western lower slopes 4744
Maerua cafra (DC.) Pax. Pine plantations on lower slopes 5871
M. rosmarinoides (Sond.) Gilg & Ben. Blyde River picnic spot 6099, 6259

Droseraceae

Drosera dielsiana Exell & Laundon. Wet areas in grassveld 4544

Crassulaceae

Kalanchoë rotundifolia Haw. Widespread succulent herb, in scrub and on banks of dongas 5154
Crassula browniana Burtt Davy. Between rocks on summit of mountain 6500, 4393
C. filamentosa Schönl. Small pulpy herb on summit of mountain 6458
C. lineolata Dryand. Prostrate herb on Blyde footpath 5526
C. parvisepala Schönl. Succulent shrub on summit of mountain 5085, 5072
C. rubicunda E. Mey. ex Harv. Moist areas in rocky situations 4371, 4847
C. setulosa Harv. Herb in small annual pools on summit 4625
C. thorncroftii Burtt Davy. Herb on forest floor 4995

Saxifragaceae

Choristylis rhamnoides Harv. Shrub on northern slopes of mountain 4999, 5571

Pittosporaceae

Pittosporum viridiflorum Sims. Rocky outcrops and forest margins 4690, 5974

Hamamelidaceae

Trichocladus grandiflorus Oliv. Large forest tree 4398, 4918

Rosaceae

Rubus pinnatus Willd. Widespread scrambler on edge of forest 5014
R. rigidus Sm. Fringe of forest 4562, 6249
Alchemilla cryptantha Steud. Herb on side of road 4694
A. rehmannii Engl. Herb on forest floor 4992, 6442
Agrimonia odorata Mill. Small shrub in scrub on forest margin 4605, 6369
Cliffortia linearifolia Eckl. & Zeyh. Shrub on open area in indigenous forest 4781, 5090
C. nitidula (Engl.) R.E. Fr. & T. C. E. Fr. ssp. *pilosa H. Weim.* *Widespread* shrub along streams and on mountain summit 6198, 5588
C. repens Schltr. Small shrub on mountain summit and slopes 4475
C. serpyllifolia Cham. & Schlechtd. Small shrub common between rocks on mountain 4828
C. strobilifera Murr. On mountain slopes 6132B
Prunus africana (Hook.f.) Kalkm. Tall tree scattered in high forest 4978, 5146
Parinari curatellifolia Planch. ex Benth. ssp. *mobola* (Oliv.) R. Grah. Evergreen tree, tall grassveld, on lower slopes of mountain ...... —

Connaraceae

Cnestis natalensis (Hochst.) Planch. & Sond. Liane in mountain forest 4733, 5058

Leguminosae

Mimosoideae

Albizia versicolor Welw. ex Oliv. Small to medium-sized tree in Lowveld ...... —
Acacia ataxacantha DC. In scrub and scrub forests in kloofs and lower areas 4556, 5005
A. caffra (Thunb.) Willd. Small trees, in lower areas ...... —
A. davyi N.E. Br. In Blyde River poort 5016, 6068
A. gerrardii Benth. Lowveld tree ...... —
A. karroo Hayne. Small to medium-sized tree. Abundant in seral scrub and savanna of lower foothills ...... —

A. robusta Burch. Common tree on banks of Blyde River —

A. schweinfurthii Brenan & Exell var. *schweinfurthii*. Untidy woody scrambler. common in thick bush of lower foothills —

A. sieberana DC. var. *woodii* (Burrt Davy) Keay & Brenan. Medium-sized tree on foothills of mountain —

Dichrostachys cinerea (L.) Wight & Arn. ssp. *nyassana* (Taub.) Brenan. Infrequent in seral grassveld and scrub on lower slopes 5041

Entada spicata (E. Mey.) Druce. Robust liane of scrub forest and high forest 4732, 6073

Caesalpinioideae

Schotia brachypetala Sond. Gallery forest —

Bauhinia galpinii N.E. Br. In scrub forest of Lowveld —

Piliostigma thonningii (Schum.) Milne-Redhead. Shrub or small tree, locally on foothills —

Cassia laevigata Willd. Banks of Blyde River 4601, 5523

C. mimosoides L. Along footpath on western mountain slopes 4542

C. occidentalis L. Small shrub in plantation and disturbed areas 5856, 6368

C. petersiana Bolle. Small shrub in tall grassveld of lower foothills —

Pterolobium exosum (Gmel.) Bak.f. Robust, thorny scrambler in foothills scrub 4614

Caesalpinia decapetala (Roth.) Alston. Aggressive spiny exotic scrambler in foothill scrub —

Peltophorum africanum Sond. Tree on foothills 6064

Papilionatae

Calpurnia aurea (Ait.) Benth. Small tree, fairly widespread in high forest 4886

C. sp. Small tree in mountain forest 4669

Pleiospora cajanifolia Harv. Small shrub with yellow flowers 4341

Crotalaria capensis Jacq. Small shrub in pine plantation and forest margin 4555, 5896

C. doidgeae Verdoorn. Small shrub on lower slopes 5473, 6394

C. recta Steud. Small shrub on forest margin 4598

Argyrolobium collinum Eckl. & Zeyh. Small herb on summit of mountain 4820

A. tomentosum (Andr.) Druce. Summit of mountain 4476, 5078

Indigofera garckeana Vatke. Forest margins 6017

I. hedyantha Eckl. & Zeyh. Herb on mountain summit 6319, 6006

I. swaziensis Bol. North-eastern slopes, small shrub, with red flowers 5015

I. tristoides N.E. Br. Small shrub, on north-eartern slopes in grassveld 5007

I. sp. cf. *I. malacostachys* Benth. Open space in forest 6050

Psoralea pinnata L. Shrub with mauve flowers on moist areas, on summit of mountain 4379, 4482

Mundulea sericea (Willd.) A. Chev. Common in tall grassveld of foothills and Blyde Canyon —

Sesbania cinerascens Welw. ex Bak. Small shrub on slopes of mountain 4604

Ormocarpum trichocarpum (Taub.) Harms ex Burtt Davy. Small shrub on water-logged areas on slopes of mountain —

Smithia erubescens (E. Mey.) Bak.f. Small shrub in grassy patches 6243, 6284

S. thymodora Bak.f. Small shrub in mountain grassveld 4547, 4655

Zornia capensis Pers. Small herb in mountain grassveld 6441

Desmodium hirtum Guill. & Perr. Herb in mountain grassveld 6437, 5976

D. repandum (Vahl) DC. In scrub and grassveld of forest margins 4941, 4332

Pseudarthria hookeri Wight & Arn. Shrubby forb in plantations 4577

Dalbergia armata E. Mey. Robust liane of gallery and riverine scrub, scrub forest and forest 4[illegible], 6247

Pterocarpus angolensis DC. Tall tree on foothills of Drakensberg 5056

P. rotundifolius (Sond.) Druce. Blyde River Canyon —

Lonchocarpus capassa Rolfe. Stunted tree in Blyde River Canyon [illegible]399

Abrus fruticulosus Wall. ex Wight & Arn. Slender subwoody twiner. Widespread in scrub, savanna and woodland —

A. precatorius L. Small twiner in Lowveld scrub —

Erythrina lysistemon Hutch. Tree in scrub and gallery forest of Lowveld —

Mucuna coriacea Baker. Robust soft perennial twiner in pine plantations 4566

Canavalia virosa (Roxb.) Wight & Arn. Herbaceous twiner near streams, low country —

Rhynchosia caribaea DC. Forest margins 4592, 5080

R. clivorum S. Moore. Small shrub with yellow flowers in pine plantations 4469

R. hirsuta Eckl. & Zeyh. Blyde picnic spot 6391

R. sordida (E. Mey.) Schinz. Slender fruticose forb 5886

Flemingia grahamiana Wight & Arn. In grassveld on mountain summit 5537

Vigna vexillata (L.) Benth. Small soft twiner. Widespread, but restricted to grassveld and early scrub stages 5915

V. sp. Herb in grassveld 5516
Lablab niger Medik. Herb on forest margin 4595
Dolichos taubertii Bak.f. Occurs frequently in grassveld ...... —

Oxalidaceae

Oxalis corniculata L. On side of road to Blyde picnic spot 6378
O. obliquifolia Steud. ex Rich. In grassveld on NW mountain slopes 5003
O. smithiana Eckl. & Zeyh. Small herb, common in grassveld ...... —
O. sp. cf. *O. semiloba* Sond. Small herb in grassveld 5004, 6494

Linaceae

Linum thunbergii Eckl. & Zeyh. NE slopes of mountain, open bushveld 5000

Rutaceae

Fagara capensis Thunb. Small tree in scrub forest 4746, 6396
F. davyi Verdoorn. Common tree of high forest and forest margin 4632, 4674
Calodendrum capense (L.f.) Thunb. Fair-sized tree of high forest and forest margin 5928
Vepris reflexa Verdoorn. Banks of Blyde River 6105
V. undulata (Thunb.) Verdoorn. Small tree or shrub on fringe of mountain forest 5850
Teclea natalensis Engl. Small understory tree on banks of Blyde River 5495
Clausena anisata (Willd.) Hook.f. ex Benth. Shrub in Blyde Canyon 4749, 4792A

Simarubaceae

Kirkia wilmsii Engl. Tree near Blyde picnic spot 6103,6260

Burseraceae

Commiphora mollis (Oliv.) Engl. Small tree in scrub of donga ...... —
C. harveyi Engl. Small tree on banks of Blyde River 6095

Meliaceae

Ptaeroxylon obliquum (Thunb.) Radlk. Shrub in vicinity of Blyde picnic spot 6098
Ekebergia capensis Sparrm. Tree in forest 4650, 4714
E. pterophylla (C. DC.) Hofmeyr. Shrub on fringe of forest 4364, 4396
Trichilia emetica Vahl. Tall tree in gallery forest on foothills of mountain 5858

Malpighiaceae

Sphedamnocarpus galphimiifolius (Juss.) Szyszyl. Perennial slender subwoody liane of forest margins 4509, 4969

Polygalaceae

Polygala sphenoptera Fresen. On sandbank at Blyde River picnic spot 6431
P. rehmanni Chod. Small shrub in grassveld on mountain summit 6454
P. virgata Thunb. Small shrub on forest margin 4656
Muraltia flanaganii H. Bol. Small shrub on summit of mountain 6187, 4408

Euphorbiaceae

Securinega virosa (Roxb. ex Willd.) Pax & Hoffm. On road to Blyde picnic spot, shrub in dry kloof 6129, 6474
Phyllanthus reticulatus Poir. Untidy shrub or woody twiner common in thick bush of lower areas ...... —
Antidesma venosum E. Mey. ex Tul. Low spreading tree on foothills of mountain favouring moist situations 5051
Bridelia micrantha (Hochst.) Baill. Fair-sized tree on lower banks of Klaserie River 4799, 6419
B. mollis Hutch. Common in rocky areas in Lowveld 6389
Croton sylvaticus Hochst. Fair-sized tree, in high forest and forest margins 4662, 4609
Alchornea hirtella Benth. var. *glabrata* (Prain) Pax & Hoffm. Small tree on fringe of forest 6156
Acalypha punctata Meisn. Subwoody forb in grassveld and forest margins on western slopes 6380
Tragia okanyua Pax. Slender twiner in underscrub of the Lowveld areas 6114
Ricinus communis L. Weed on Blyde River bank ...... —
Jatropha hirsuta Hochst. Eastern foothills of mountain 5882
Clutia affinis Sond. Near Klaserie Waterfall 4352
C. monticola S. Moore. Western slopes of mountain 5565
C. natalensis Bernh. In water-logged area near Klaserie Waterfall 5021

Spirostachys africana Sond. Common tree in Lowveld areas —
Euphorbia cooperi N.E. Br. ex Berg. Blyde River Lowveld —
E. ingens E. Mey. ex Boiss. Blyde River Lowveld —
E. lydenburgensis Schweick & Letty. Blyde River Lowveld 5644
E. kraussiana Bernh. Small shrub in forest margin 5967
E. tirucalli L. In Blyde River Bushveld —

Anacardiaceae

Sclerocarya caffra Sond. Tall deciduous tree in Lowveld near Klaserie River 6280
Lannea discolor (Sond.) Engl. Small tree in rocky places in Lowveld —
L. edulis (Sond.) Engl. Herb in mountain grassveld, between forest station and waterfall 5854
Protorhus longifolia (Bernh.) Engl. Large forest tree 4559, 6166
Ozoroa reticulata (Bak.f.) R. & A. Fernandes. Small tree on foothills of Drakensberg —
Rhus chirindensis Bak.f. forma *legatii* (Schonl.) R. & A. Fernandes. Small tree on forest margin 6167, 5001
R. dura Schonl. Small tree or shrub on summit of mountain 4893, 4709
R. ernesti Schonl. Small tree among boulders on summit of mountain 6503
R. gueinzii Sond. Small shrub in Blyde River scrub 6109
R. intermedia Schonl. Small shrub in pine plantation 4573
R. lucida L. In forest undergrowth 4913, 6213
R. pentheri Zahlbr. Small shrub in Blyde River Poort 5513, 6074
R. pyroides Burch. Small tree on banks of Blyde River 6111, 6402
R. rehmanniana Engl. Small tree on lower western slopes of mountain 6131
R. transvaalensis Engl. Small tree in Blyde River scrub 6124, 5043
R. sp. Small shrub in undergrowth and fringe of forest 5171, 6222

Aquifoliaceae

Ilex mitis (L.) Radlk. Widespread waterside tree 4558, 4653

Celastraceae

Maytenus ocuminata (L.f.) Loes. Tree on frange of mountain forest 6014
M. heterophylla (Eckl. & Zeyh.) N. Robson. Variable small tree. In scrubby vegetation —
M. mossambicensis (Klotzsch) Blakelock var. *rubra* (Harv.) Blakelock. Small tree at altitudes upwards of about 1,300 m. 5657, 6086
M. peduncularis (Sond.) Loes. Small to fair-sized tree of undergrowth and margin forest 5948, 5655
M. undata (Thunb.) Blakelock. Small tree of margin and undergrowth 6300
Catha edulis (Vahl) Forsk. ex Endl. Widespread small tree in Lowveld regions 5652
Pterocelastrus echinatus N.E. Br. Large tree common in forest 4640A, 4691
P. galpinii Loes. Large tree in indigenous forest 4761A, 5997
P. sp. nov. Large tree in indigenous forest 5117
Cassine eucleaeformis (Eckl. & Zeyh.) Kuntze. Small tree of rain forest 6223, 6192

Icacinaceae

Apodytes dimidiata E. Mey. ex Arn. Small to medium-sized tree of forest and scrub forest 6221, 6285
Pyrenacantha grandiflora Baill. Scrambling shrub in forest 5936

Sapindaceae

Allophylus melanocarpus (Sond.) Radlk. Tree on mountain forest margin 4986
A. transvaalensis Burtt. Davy. Small tree on forest margin 5940, 6051
Pappea capensis Eckl. & Zeyh. Small tree or shrub in forest margin 4757
Hippobromus pauciflorus (L.f.) Radlk. Common in scrub forest and forest margin —

Melianthaceae

Bersama transvaalensis Turrill. Fair-sized tree of forest and forest margin 5579, 6143
B. tysoniana Oliv. Large tree in indigenous forest 4780, 5038
B. sp. Tree in mountain forest 6219, 6235
Greyia radlkoferi Szyszyl. Large shrub or small tree on NE foothills 4967
G. sutherlandii Hook. & Harv. Shrub on NE foothills 5553, 6461

Balsaminaceae

Impatiens duthieae L. Bol. Soft herb near water 4502A, 4725
I. sylvicola Burtt Davy & Greenway. Soft herb, near water on forest floor 4349, 4412

Rhamnaceae

Ziziphus mucronata Willd. Small tree, in scrubby vegetation 4652, 6070
Phyllogeiton zeyheri (Sond.) Suesseng. Small tree or shrub, widespread 6115
Scutia myrtina (Burm.f.) Kurz. Robust woody scrambler or liane 5019, 5035
Rhamnus prinoides L'Herit. Widespread shrub of scrub and scrub forest 4964, 6234
Phylica paniculata Willd. Small shrub on summit of mountain 4481, 6463
Helinus integrifolius (Lam.) Kuntze. Small woody liane or scrambler. Scrubby vegetation 4608, 4743

Heteropyxidaceae

Heteropyxis natalensis Harv. Small tree in seral scrub or savanna 4541

Vitaceae

Rhoicissus revoillii Planch. Robust woody liane of high and scrub forest 4979, 5122
R. rhomboidea (E. Mey. ex Harv.) Planch. Robust woody liane of high and gallery forest 4561, 5910
R. tomentosa (Lam.) Wild & Drummond. Very robust woody liane of high and gallery forest 4615, 4713
R. tridentata (L.f.) Wild & Drummond. Shrubby plant, on disturbed retarded grassveld ...... —
Cissus sp. Liane near river 4739
Cyphostemma anatomicum (C. A. Sm.) Wild & Drummond. Common liane of high forest and kloof ...... —
C. sp. Shrub on side of road 6370

Tiliaceae

Grewia flavescens Juss. Untidy climbing shrub with square stems, widespread ...... —
G. monticola Sond. Shrub common on rocky hills and sandy soil 6097
G. occidentalis L. Widespread straggly shrub or small tree in scrub forest 4745, 4796
Triumfetta annua L. Weed on forest margin 4594
T. pilosa Roth. var. *tomentosa* Szyszyl. ex Sprague & Hutch. Small to large annual 5480, 5517

Malvaceae

Abutilon angulatum (Guill. & Perr.) Mast. Small shrub on riverbank thickets 5497
A. fruticosum Guill. & Perr. Shrub in grassveld 5515
Pavonia columella Cav. Small shrub on riverbank 4355, 4871
Hibiscus cannabinus L. Herb in pine plantations 4585
H. meeusei Exell. Small herb in pine plantations 4567
H. pedunculatus L.f. Small shrub on riverbank 6055, 6137
H. praeteritus R. A. Dyer. Small shrub with red flowers in Blyde River Poort 5931

Bombacaceae

Adansonia digitata L. Large tree with thick stem in Blyde River Lowveld 5929

Sterculiaceae

Melhania prostrata DC. Herb with yellow flowers in fallows at Blyde River Poort 5954, 6101
Dombeya burgessiae Gerr. ex Harv. Robust shrub in scrub on mountain summit 4962
D. cymosa Harv. Robust shrub on banks of Blyde River 5502
D. rotundifolia (Hochst.) Planch. Small Lowveld tree ...... —
D. pulchra N.E. Br. Robust shrub in pine plantations 4581, 6371
Sterculia murex Hemsl. Tree in kloof and on rocky outcrops of foothills of "The Berg" ...... —

Ochnaceae

Ochna holstii Engl. In scrub on banks of Blyde River 5654, 5918
O. natalitia (Meisn.) Walp. Small shrub in scrub forest 6237, 6418
O. oconnorii Phillips. Fair-sized understory and canopy tree in high forest 4713, 4754

Guttiferae

Hypericum lalandii Choisy. Widespread pioneer of forest margins and moist areas 6021, 5867
H. revolutum Vahl. Spreading shrub along forest margin 4367, 4450
H. roeperianum Schimper. Shrub with yellow flowers on side of road 4975, 5529

Canellaceae

Warburgia ugandensis Sprague. Tree in Lowveld kloofs 5503, 5950

Flacourtiaceae

Rawsonia lucida Harv. & Sond. Understory tree of high forest 4528, 5851
Kiggelaria africana L. Variable tree in upper montane forest 4667, 4646
Gerrardina foliosa Oliv. Shrub between boulders on summit of mountain 5848
Homalium dentatum (Harv.) Warb. Infrequent in riparian forest 6082, 2507
Trimeria rotundifolia (Hochst.) Gilg. Lower parts in bush 6065, 4647
Aphloia theiformis (Vahl) Benn. Shrub near Klaserie picnic spot 4911, 5133
Dovyalis caffra (Hook.f. & Harv.) Warb. Spiny shrub in thick bush ...... —
D. rhamnoides (Burch.) Harv. Shrub with spines in wooded kloof 6147

Passifloraceae

Adenia digitata (Harv.) Engl. Widespread herbaceous scrambler with large woody root-stock 4740, 6375
A. gummifera (Harv.) Harms. Widespread liane on forest margins 4736, 5957

Begoniaceae

Begonia caffra Meisn. Against moist cliffs in indigenous forest 4529
B. sp. Shrub with orange flowers, against moist rocks in indigenous forest 4365, 4527

Thymelaeaceae

Peddiea africana Harv. Shrub or small tree of high forest 5147A, 6232
Lasiosiphon polyanthus Gilg. Small shrub with yellow flowers in forest margin 6481, 4445
L. splendens Endl. Mountain grassveld shrub with yellow flowers 5125
Passerina montana Thod. Ericoid shrub on mountain summit between rocks 4478, 4836
Dais cotinifolia L. Small tree on lower slopes of mountain 4793

Rhizophoraceae

Cassipourea gerrardii (Schinz) Alston. Understory or canopy tree of high forest 4707, 4877

Combretaceae

Combretum apiculatum Sond. In Lowveld ...... —
C. collinum Fresen. Small tree in Lowveld ...... —
C. erythrophyllum (Burch.) Sond. Large tree on lower slopes of mountain 6281
C. imberbe Wawra. Large tree in Blyde River Lowveld ...... —
C. kraussii Hochst. Tree in forest 4676, 4761
C. zeyheri Sond. Small tree in Lowveld 6110
C. sp. Small tree on Blyde River bank 6094
Quisqualis parviflora Gerr. Robust woody liane in forest 5585, 6043
Terminalia phanerophlebia Engl. & Diels. Small tree in thick bush on lower slopes of mountain 6388

Myrtaceae

Eugenia natalitia Sond. Small tree in mountain forest 4630, 5157
E. paniculata Banks. ex Gaertn. var. *australis* Baill. Exotic shrub in disturbed areas 4730
E. sp. nov. (Renny 266 + 181). Small shrub on banks of Blyde River ...... —
Syzygium cordatum Hochst. ex Harv. & Sond. Lowveld riparian tree 4496, 4800
S. gerrardii (Harv. ex Hook.f.) Burtt Davy. Large tree on mountain forest 4636, 4557
S. guineense (Willd.) DC. Lowveld riparian tree 4801, 5542

Melastomataceae

Antherotoma naudinii Hook.f. Small herb in disturbed areas 4374
Dissotis canescens (E. Mey. ex Grah.) Hook.f. Suffrutex of earlier stages of hydrosere 4368, 4506

Halorrhagidaceae

Gunnera perpensa L. Perennial rhizomatous herb in water-logged areas 5065, 6516

Araliaceae

Cussonia natalensis Sond. Fairly large tree, scattered on rocky outcrops between patches in forest 5158
C. spicata Thunb. Tree of mountain forest 6283
C. umbellifera Sond. Large tree of mountain forest 4399, 4920
Seemannaralia gerrardii (Seeman) Vig. Small tree in scrub forest of western slopes 5949

Umbelliferae

Sanicula elata Ham. ex D. Don. Low herb on forest floor 4501, 5032
Alepidea amatymbica Eckl. & Zeyh. Herb in mountain grassveld 5097
Heteromorpha pubescens Burtt Davy. Shrub on riverbank and forest margin 5501, 6126
H. trifoliata (Wendl.) Eckl. & Zeyh. Small tree on forest margin 4617, 4965
Steganotaenia araliacea Hochst. Tree on rocky outcrops on banks of Blyde River 5500

Cornaceae

Curtisia dentata (Burm.f.) C. A. Sm. Fair-sized tree of high forest and forest margin 4642, 4675

Ericaceae

Vaccinium exul H. Bol. Small shrub in mountain grassveld 4712, 5036
Erica caffrorum H. Bol. Scrub on summit of mountain 5843, 6351
E. drakensbergensis Guth. & H. Bol. Small shrub on side of mountain road 4474
E. leucopelta Tausch var. *ephebioides* H. Bol. Small shrub on summit of mountain 4395, 4837

Myrsinaceae

Maesa lanceolata Forsk. Widespread small tree in forest margin and mountain grassveld 4551, 4627
Myrsine africana L. Small shrub on forest margin 5115, 6190
Rapanea melanophloeos (L.) Mez. Medium-sized tree of subclimax forest 4454, 4644

Plumbaginaceae

Plumbago auriculata Lam. Shrub on rocky outcrop 6104
P. zeylanica L. Shrub in scrub forest and common grassveld ...... —

Sapotaceae

Bequaertiodendron magalismontanum (Sond.) Heine & J. H. Hemsley. Shrub or small tree on lower foothills 4886, 5150
B. natalense (Sond.) Heine & J. H. Hemsley. Small tree in shrub forest 5017
Mimusops zeyheri Sond. Fair-sized to large tree in foothill kloofs 5935, 6079
M. obovata Sond. Small tree on fringe of mountain forest 5925

Ebenaceae

Euclea crispa (Thunb.) Guerke. Large tree of mountain forest 4959, 6475
E. divinorum Hiern. Small tree or shrub on mountain slope 5012, 5042
Diospyros lycioides Desf. subsp. *sericea* (Bernh.) De Wint. Low shrub, widespread in earlier stages of succession 5055, 5939
D. mespiliformis Hochst. ex A. DC. Tree on riverbanks, outcrops and hills 5934
D. whyteana (Hiern) F. White. Understory tree of high forest 4686, 4634

Oleaceae

Schrebera alata (Hochst.) Welw. Large tree common in rain forest 4378, 4391
S. argyrotricha Gilg. Shrub, common in scrub forest of Blyde River Poort 6075
Linociera foveolata (E. Mey.) Knobl. Large tree in mountain forest 4873
L. foveolata (E. Mey.) Knobl. ssp. *major* Verdoorn. Large tree in mountain forest 6154
Olea africana Mill. Blyde River scrub forest 5653
O. capensis L. ssp. macrocarpa (C. H. Wr.) Verdoorn. Fair-sized canopy tree of high forest 4634, 4665
O. woodiana Knobl. Large tree in indigenous forest 5029
Jasminum abyssinicum Hochst. ex DC. Twining shrub in forest margin 4377
J. fluminense Vell. Woody liane in mountain forest 4651
J. streptopus E. Mey. var. *transvaalensis* (S. Moore) Verdoorn. Small shrub on forest margin 4737, 6061

Loganiaceae

Strychnos decussata (Pappe) Gilg. Medium-sized to small tree in Lowveld scrub ...... —
S. spinosa Lam. Small tree in Lowveld bushveld 6072
Anthocleista grandiflora Gilg. Tree with large leaves on banks of Klaserie River on lower foothills 5506
Nuxia congesta R. Br. ex Fresen. Small to fair-sized tree of mountain forest 6205, 6022
N. floribunda Benth. Small to fair-sized tree, high forest and forest margins ...... —
N. oppositifolia (Hochst.) Benth. Shrub widespread on riverbanks and river courses 6081, 6403
Buddleia salviifolia (L.) Lam. Shrub in forest margins 4982, 5564

GENTIANACEAE

Sebaea erosa Schinz. Small herb with yellow flowers in grassveld on mountain summit 4849, 5840
S. macrophylla Gilg. Herb with yellow flowers on top of mountain in moist places 4380, 4483

APOCYNACEAE

Carissa bispinosa (L.) Desf. ex Brenan var. *acuminata* (E. Mey.) Codd. Widespread shrub in undergrowth and along margin of forest 4768, 5853
C. edulis Vahl. Large subscandent shrub or small tree in scrub 6512, 6078
Landolphia capensis Oliv. Liane with latex, in forest 4677
Rauvolfia caffra Sond. Large tree on banks of Klaserie River 5053
Strophanthus speciosus (Ward & Harv.) Reber. Liane in mountain forest 6274

ASCLEPIADACEAE

Xysmalobium acerateoides N. E. Br. Perennial forb in mountain grassveld 5022
X. confusum Scott-Elliott. Robust perennial forb in mountain grassveld 4966
X. undulatum (L.) Ait.f. Herb in mountain grassveld 6387, 6127
Asclepias decipiens N. E. Br. Herb in mountain grassveld. 6121
A. gibba Schltr. Herb in pine plantation, on side of road 5865
A. physocarpa Schltr. Tall weed of disturbed veld 5892
A. stellifera Schltr. Herb on slopes of mountain 5944
Sarcostemma viminale R. Br. Leafless succulent perennial twiner ...... —
Secamone alpinii Schultes. Slender liane in high forest 6211, 4980
S. frutescens Decne. Liane on rocky ridges 5520
S. gerrardii Harv. ex Benth. & Hook.f. Liane in high and marginal forest 5018, 4638
Brachystelma pulchellum Schltr. Bulbous shrub in grassveld on top of mountain 6322
Riocreuxia picta Schltr. Subwoody twiner in high forest 6361, 6031
R. torulosa Decne. Subwoody twiner in scrub forest 4670
Marsdenia dregea Schltr. Slender twiner in Lowveld scrub on banks of Blyde River 6390

CONVOLVULACEAE

Convolvulus ulosepalus Hall.f. Herb with white flowers on foothills of mountain 6322
Ipomoea albivenia (Lindl.) Sweet. Woody twiner on rocky places 6116
I. eriocarpa R. Br. Herbaceous creeper 4579
I. wightii (Wall.) Choisy. Widespread and perennial twiner in grassveld and scrub forest 5890

BORAGINACEAE

Ehretia amoena Klotzsch. In Lowveld scrub ...... —
Trichodesma zeylanicum R. Br. Annual weed in fallows in Blyde Canyon 5952
Cynoglossum lanceolatum Forsk. Weed in pine plantation 6060
Myosotis afropalustris C. H. Wr. Small herb in grassveld on foothills of mountain 5893

VERBENACEAE

Lantana camara L. Weed in foothill scrub 4603
L. mearnsii Moldenke. Weed in foothill scrub 4574
L. montevidensis Briq. Herb along roads 4659
Lippia javanica (Burm.f.) Spreng. Small shrub on lower foothills 6514, 5040
Chascanum sp. Small shrub on lower foothills 4597
Duranta repens L. Garden escape of disturbed scrub and scrub forest ...... —
Gmelina arborea Roxb. Foreign tree on foot of mountain 6049
Clerodendrum glabrum E. Mey. Shrub or small tree of early scrubby seral stages 5057, 4570

LABIATAE

Leonotis leonurus (L.) Ait. Conspicuous herb of forest margins and grassveld areas 4588, 5166
Leucas glabrata R. Br. Shrub in scrub forest in grassveld 5508
Stachys aethiopica L. Creeping shrub with mauve flowers on side of road 6337
S. galpinii Briq. In mountain grassveld near waterfall 6039
S. cf. *S. rehmannii* Skan. Laxly spreading low forb 5139
Endostemon obtusifolius (E. Mey.) N. E. Br. Herb in forest margin 4921, 6056
Pycnostachys reticulata (E. Mey.) Benth. Soft open shrub of moist places 4611
P. urticifolia Hook. Widespread soft shrub of open places 4572, 5524
Plectranthus arthropodus Briq. Robust herb on forest margin 4375
P. fruticosus L'Hérit. Robust herb on forest margins 4460, 4458
P. laxiflorus Benth. Robust herb on forest margins 4448, 4345
P. myrianthus Briq. Herb in mountain grassveld 5100

P. nummularius Briq. Prostrate herb in rock areas 6136
Coleus tysonii (Guerke). Herb on forest margin 5140
Hoslundia opposita Vahl. Herb in mountain grassveld 6139, 6374
Iboza riparia N. E. Br. On banks of Blyde River 6780, 5496
Syncolostemon eriocephalus Verdoorn. Shrub in rock crevices on mountain 5587, 4838

Solanaceae

Withania somnifera (L.) Dun. Shrub in forest region 6794
Physalis peruviana L. Weed in disturbed areas 5527, 4866
Solanum aculeatissimum Jacq. Shrub along road 4895
S. geniculatum E. Mey. Shrub on forest margin 4756
S. giganteum Jacq. Shrub in marshy area 4600, 4874
S. indicum L. Weed on side of road 4896
S. panduraeforme E. Mey. Weed of disturbance 4798, 4575
Datura stramonium L. Well-known weed —

Scrophulariaceae

Halleria lucida L. Widespread tree in mountain, forest and on river banks —
Nemesia melissaefolia Benth. Small herb on mountain summit 5608, 5616
Diclis reptans Benth. Herb on fringe of forest 5968
Bowkeria cymosa MacOwan. Shrub or small tree on forest margin 4361A, 4645
Sutera accrescens Hiern. Suffrutescent forb —
S. floribunda (Benth.) Kuntze. Lax suffrutescent forb 6202, 5536
Zaluzianskya katherinae Hiern. Herb in rock crevices 5620
Z. lychnidea Walp. Shrub between rocks 4811
Craterostigma wilmsii Engl. ex Diels. Herb in seasonal pools and rocks on summit of mountain 4517
Ilysanthes conferta Hiern. Submerged herb in seasonal pools on summit of mountain 6339
Hebenstreitia comosa Hochst. Herb on summit of mountain 4833
H. dentata L. Herb on summit of mountain 6768
Selago elata Rolfe. Herb of grassveld on forest margin 4449, 6769
S. muddii Rolfe. Herb on summit of mountain 5834
S. nelsoni Rolfe. Herb on summit of mountain 4522
S. villosa Rolfe. Herb with blue flowers on top of mountain 4383, 4524
S. sp. Small shrub on mountain slope 6492
Cycnium racemosum Benth. Parasite in grassveld 6460
Rhamphicarpa tubulosa Benth. Shrub on river-banks 6495
Harveya coccinea Schtr. Widespread parasitic herb 4683
H. huttonii Hiern. Root parasite on forest floor in mountain forest 6258A, 5894

Bignoniaceae

Tecomaria capensis Spach. Twining shrub in Lowveld scrub on river-banks 5167

Gesneriaceae

Streptocarpus confusus Hilliard. Herb on forest floor 6635, 4727
S. cyaneus S. Moore. Herb in forest on mountain slope 6048, 6478
S. micrantha C. B. Cl. On rocks in indigenous forest 4507A, 4997
S. parviflorus Hook.f. Small tufted herb on high forest floor 4971
S. pusillus Harv. In shade of rocks on mountain summit 4817, 4816
S. wilmsii Engl. Epiphyte on trees in indigenous forest 4951, 4329A

Acanthaceae

Thunbergia alata Boj. ex Sims. Twiner in forest margin 6372
T. natalensis Hook. Shrub on forest floor 5895, 5916
Barleria gueinzii Sond. Herb in undergrowth 4602
B. rotundifolia Oberm. Herb on floor of riparian forest 5498
Sclerochiton harveyanus Nees. Sprawling to subscandent shrub. Abundant in high forest undergrowth 4899, 4514
Crossandra greenstockii S. Moore. Herb in grassveld 5010, 5859
Dicliptera clinopodia Nees. Undershrub in kloofs and mountain forest 6730, 5491
D. zeylanica Nees. Shrub on fringe of mountain forest 4463
Hypoestes aristata R. Br. Undershrub of sour grassveld and scrub 5552
H. triflora Roem. & Schult. Shrub on river-banks and forest margin 5128
H. verticillaris R. Br. Small shrub in undergrowth 5551, 5519
Mackaya bella Harv. Shrub in open parts of high forest 4673
Duvernoia adhatodoides E. Mey. ex Nees. Shrub prominent in substrata 6041, 5147
Ruttya ovata Harv. Shrub on Blyde River banks 5494, 6400
Justicia petiolaris E. Mey. Undergrowth of Blyde River forest 5509
J. protracta (Nees) T. Anders. Undershrub of Blyde River riparian forest 5507

Plantaginaceae

Plantago lanceolata L. Exotic herb in grassveld at forest station 6436

Rubiaceae

Oldenlandia rupicola (Sond.) Kuntze. Herb on summit of mountain 6764, 4821A
Conostomium natalense (Hochst.) Brem. Herb in pine plantations 4510
Adina microcephala (Del.) Hiern. var. *galpinii* (Oliv.) Hiern. Large tree on banks of Blyde River 5052, 6089
Cephalanthus natalensis Oliv. Liane in mountain forest 6798, 6171
Gardenia amoena Sims. Strangling shrub in scrub and scrub forest 5538, 6093
G. spatulifolia Stapf & Hutch. Small Lowveld tree ...... —
Rothmannia capensis Thunb. Small to medium-sized understory tree of high forest 5881, 4881
Oxyanthus gerrardii Sond. Large understory shrub of high forest 4405, 4626
Tricalysia capensis (Meisn.) Sim. Small understory tree in high forest 6277, 4400
T. lanceolata (Sond.) Burtt Davy. Small shrub in forest 6067
Pentanisia angustifolia Hochst. Herb in pine plantation 4904
P. prunelloides (Klotzsch ex Eckl. & Zeyh.) Walp. Herb on forest margin 4446, 4914
Vangueria cyanescens Robyns. Small understory tree or shrub ...... —
V. infausta Burch. Variable small tree in Lowveld areas ...... —
Canthium ciliatum (Klotzsch) Kuntze. Small understory tree in forest 5965
C. gueinzii Sond. Stout woody liane of high forest, and forest margins 6168, 4792
C. mundianum Cham. & Schlechtd. Shrub on stony and rocky ridges in forest areas 6087, 6473
C. obovatum Klotzsch. Undershrub in mountain forest 5123, 4882
C. ventosum (L.) S. Moore. Small tree on fringe of forest 5906, 6231
Pachystigma macrocalyx (Sond.) Robyns. Shrub in undergrowth 6276
Fadogia tetraquetra K. Krause. Herb on mountain slopes 5958, 6069
Pavetta assimilis Sond. Scrub on banks of Blyde River 5489
P. lanceolata Eckl. Small tree or shrub on high forest margin 6785, 6042
P. schumanniana F. Hoffm. ex K. Schum. Shrub in Blyde River Lowveld 6119
Psychotria capensis (Eckl.) Vatke var. *capensis*. Small understory tree in high forest 4663, 4633
P. zombamontana (Kuntze) Petit. Small understory tree in forest 4729A, 4668
Galopina circaeoides Thunb. Herb on forest floor 4994, 4324A
Anthospermum ammanioides S. Moore. Shrub on slopes of mountain 6128
A. herbaceum L.f. Prostrate herb on mountain summit 6341, 5596
A. hispidulum E. Mey. Prostrate herb on mountain summit 4345, 5995
Otiophora calycophylla (Sond.) Schltr. & K. Schum. Small shrub on summit of mountain 6318
O. cupheoides N.E. Br. Small shrub in open areas and forest margins 4523, 4831
Rubia petiolaris DC. Straggling shrub on forest margins 4606

Dipsacaceae

Scabiosa columbaria L. Widespread herb in mountain grassveld 5009, 4983

Cucurbitaceae

Cucumis africanus L.f. Herb in mountain grassveld 6511
C. sp. Herb in tall grassveld on foothills of mountains 5877
Trochomeria hookeri Harv. Slender soft climber in grassveld on foothills of mountains 5075
Peponium mackenii (Naud.) Engl. Climbing herb in riparian scrub 6404
Coccinia adoensis (Hochst. ex A. Rich.) Cogn. Herbaceous climber in seral grassveld and forest scrub 6385
C. palmata (Sond.) Cogn. Twiner in pine plantation 5531, 6063
C. sessilifolia (Sond.) Cogn. Twiner in shrub forest ...... —
C. variifolia A. Meeuse. Soft climber of the openings in high forest 6133A, 6511

Campanulaceae

Wahlenbergia undulata (L.f.) A.D. Herb in mountain grassveld ...... —
W. virgata Engl. Herb between boulders on mountain summit 6195
Lobelia decipiens Sond. Small herb, pioneer on bare soil in wet places 6561, 5868
L. filiformis Lam. var. *krebsiana* (Presl) E. Wimm. Small herb in marshy grassveld 6019
L. laurentioides Schltr. Herb spreading flat on ground 5087
L. pteropoda (Presl) A. D. Herb on forest floor 4697
Monopsis kowynensis E. Wimm. Small herb on moist places on summit of mountain 6020, 6180
M. stellarioides (Presl) Urb. var. *stellarioides* E. Wimm. Herb on moist places of forest margins ...... —

COMPOSITAE

Vernonia ampla O. Hoffm. Shrub up to 3 m high in scrub of forest, on foothills of mountain 6620, 4580
V. corymbosa (Thunb.) Less. Small shrub on mountain slopes 4658, 5099
V. crataegifolia Hutch. Shrub on eastern mountain slopes 5418, 5534
V. oligocephala (DC.) Sch. Bip. ex Walp. Herb in grassveld on lower slopes 6507
V. shirensis Oliv. et Hiern. Tall shrub in pine plantations 4565, 5164
V. umbratica Oberm. Small shrub on forest margin 4726, 4540
Ageratum conyzoides L. Herb in bluegum plantation 5165
Mikania cordata (Burm.f.) Robinson. Liane in scrub forest in forest margin 6811, 5530
Mikaniopsis sp. Liane infrequently scattered in high forest 5541
Dichrocephala integrifolia (L.f.) Kuntze. Herb in forest margin 4888
Erigeron canadensis L. Weed in mountain grassveld ...... —
Nidorella auriculata DC. Herb in mountain and foothill grassveld 4923, 4869
Conyza ivaefolia (L.) Less. Spreading small shrub on banks of Blyde River 6057, 4599
C. hochstetteri Sch. Bip. Herb in scrub on banks of Blyde River 6268
Brachylaena huillensis O. Hoffm. Shrub or small tree in mountain areas 5103
B. transvaalensis Phill. & Schweick. Large forest tree 5033
Tarchonanthus galpinii Hutch. & Phill. Small tree on rocky ridges in mountain forest 5098
Laggera pterodonta (DC.) Sch. Bip. Weed of disturbed sites ...... —
Cassinia phylicaefolia (DC.) J. M. Wood. Herb in mountain grassveld 5013, 5104
Helichrysum acutatum DC. Herb on summit of mountain 6485, 6037
H. appendiculatum (L.f.) Less. Small herb in mountain grassveld 4782, 4903
H. decorum DC. Herb with yellow flowers on mountain slopes 5572
H. aureum (Houtt.) Merrill. Herb on side of road 4403
H. latifolium (Thunb.) Less. Herb on summit of mountain 6327, 5979
H. lepidissimum S. Moore. In grassveld on slopes of mountain 4621, 4472
H. mechowianum Klatt. Herb on forest floor, mountain slope 5947
H. mundii Harv. Herb in mountain grassveld 4616
H. nudifolium (L.) Less. var. *quinquenerve* (Thunb.) Moeser. Weed in pine plantation 4885
H. obductum H. Bol. Herb on summit of mountain 6197
H. odoratissimum (L.) Less. Herb in marshy grassveld 6241, 4834
H. platypterum DC. Herb in mountain grassveld 5096
H. setosum Harv. Small shrub on mountain slopes 6788, 4660
H. sutherlandii Harv. Herb on rocky cliffs at waterfall 4351
H. subglomeratum Less. Herb with yellow flowers, on plateau 5377
H. swynnertonii S. Moore. Herb in mountain grassveld 6489
H. undatum (Thunb.) Less. Subwoody forb-grassveld ...... —
H. wilmsii Moeser. Herb in mountain grassveld 5101, 4335
H. sp. nov. aff. aff. H| *wilmsii* Moeser. Herb in marshy mountain grassveld 4775
H. sp. nov. (= Smuts & Gillett 2375, Codd 3336 +6202). Herb on summit of mountain 6176
Stoebe vulgaris Levyns. Spreading ericoid shrub in mountain grassveld 4905
Macowania tenuifolia M. D. Hend. Small shrub on summit of mountain 5617, 6196
Athrixia elata Sond. Small shrub in mountain grassveld 5535
A. phylicoides DC. Mountain grassveld 6789
Philyrophyllum schinzii O. Hoffm. In grassveld on banks of Blyde River 5490
Anisopappus junodii Hutch. Small shrub on summit of mountain 4908, 5656
Acanthospermum australe (Loefl.) Kuntze. Small shrub in mountain grassveld 5044
Aspilia mossambicensis (Oliv.) Wild. Shrub with yellow flowers on river bank 6393
A. natalensis (Sond.) Wild. Shrub on banks of river near disturbed area 6096
Tithonia tagetiflora Desf. On side of road near Blyde picnic spot 6122
Galinsoga parviflora Cav. Weed of disturbance in moist area 5634
Eumorphia davyi H. Bol. Small shrub with white flowers on top of mountain 4835
Schistostephium heptalobum (DC.) Oliv. & Hiern. Herb along road on mountain summit 4394
Artemisia afra Jacq. Herb in mountain grassveld 6508
Lopholaena disticha (N. E. Br.) S. Moore. Shrub in mountain grassveld 5112, 5612
Crassocephalum crepidioides (Benth.) S. Moore. Herb on summit of mountain 4465
C. picridifolium (DC.) S. Moore. Herb in pine plantation 6504
Cineraria sp. Liane in forest margins 4752
Senecio barbellatus DC. Herb on mountain summit 6448
S. caudatus DC. Herb in mountain grassveld 6242
S. coronatus Harv. Herb on mountain plateau 6193, 6338
S. deltoideus Less. Undergrowth on Blyde River banks 5493
S. erubescens Ait. Herb in moist areas 4773, 6286
S. galpinii Hook.f. Herb. in mountain grassveld 5023
S. junodii Hutch. & Burtt Davy. Small shrub in forest margins 4347

S. mikanioides Otto. Slender liane in mountain forest 5114
S. orbicularis Sond. In grassveld on slopes of mountain 5002, 6353A
S. pandurifolius Harv. Tall herb in grassveld of lower slopes 4612
S. polyanthemoides Sch. Bip. Herb in mountain grassveld 6488, 4563
S. pterophorus DC. Herb in marshy grassveld 4887, 4342
S. quinquelobus DC. Slender liane in mountain forest 4453
S. speciosus Willd. Herb in mountain grassveld 6252, 6038
S. tamoides DC. 4372, 5086
Euryops pedunculatus N.E. Br. Small shrub on summit of mountain 5613
Haplocarpha scaposa Harv. Herb on summit of mountain 4977, 6326
Hirpicium bechuanense (S. Moore) Roessl. Weed on fallows in Blyde River Poort 5955
Berkheya insignis (Harv.) Thell. Small herb in grassveld on earstern slopes 5879, 4976
B. latifolia Wood & Evans. Herb on banks of Klaserie River 4361
B. radula (Harv.) De Wild. Near water at Klaserie Waterfall 4925
Gerbera jamesonii H. Bol. ex Hook.f. On banks of Blyde River 5512
G. kraussii Sch. Bip. On banks of Blyde River 6386

Book Review

WILD FLOWERS OF THE NATAL DRAKENSBERG by W. R. TRAUSELD. *Cape Town: Purnell.* 1969. *Pp. xxxi* + 220, 814 *colour plates. Price* R11.50.

This is the first book published for the layman on the flora of the Natal Drakensberg. As such, it fills a great need. The Drakensberg is visited by thousands of holidaymakers each year, many of whom have a special interest in the wild flowers of the mountains.

The book which runs to 220 pages contains, first of all, a list of many of the plants collected by Mr. Trauseld in the Royal Natal National Park and the Giant's Castle Game Reserve and by the reviewer in the Cathedral Peak area. The list excludes grasses and sedges. Following the list is a table of flowering times and then colour photographs of 521 species, each of which is supported by a short 2 to 5-line description of the plant, its habitat, altitudinal range, flowering period and frequency. Mr. Trauseld points out that the altitudes given are based on his own experience in the two areas he was concerned with. Also, the frequency data are not applicable to the Natal Drakensberg as a whole. It is important to remember these two points, otherwise one could be led astray.

The chief criticism I have of the work is the way in which individual flowers or inflorescences have often been plucked and placed on rocks or inserted in holes or crevices in boulders presumably to eliminate unnecessary movement of the subjects during photography. The 'Berg, of course, can be a windy place. The photographs of a head of *Protea multibracteata* and a raceme of *Greyia sutherlandii* projecting from a rock crevice and hole respectively are, to me, not only quite unnatural, but ecologically inaccurate and aesthetically unpalatable — similarly the photographs of *Oxalis smithiana, Vellozia viscosa, Papaver aculeatum* and *Pelargonium luridum* in which the plants are lying prostrate on a rock surface with their bases weighted down by small stones. Surely Mr. Trauseld could have used a tripod with clamp and eliminated the effect of wind by some more sophisticated method?

The photographs vary in quality from extremely poor, e.g. *Crocosmia aurea, Erica woodii, E. westii, Buddleia salviifolia, Psammotropha mucronata* and *Peucedanum connatum* to very good e.g. some of the asclepiads. On the whole, the close-ups of flowers and inflorescences are better than the habit photographs. In the latter the plants tend to merge with the background, e.g. *Habenaria clavata, Satyrium longicauda, Disa stachyoides* and *Silene burchellii*. The colour reproduction is not always true, e.g. *Leonotis dysophyllus, Protea multibracteata* and *P, dracomontana*. The plate of *Anisotoma pedunculata* has been printed upside down.

There are several unfortunate typographical errors, e.g. *Crytanthus* for *Cyrtanthus* on p. xii, *Tulbughia* for *Tulbaghia* on p. 17, *Bowkeria verticellata* for *B. verticillata* on pp. 166 and 167, *Vernonia hirsutu* for *V. hirsuta* on pp. 194 and 195, *Eulophia welwitchii* for *E. welwitschii* on p. 75, *Diascia purpurea* for *D. purpurea* on pp. 164 and 165, and Solonaceae for Solanaceae on p. 126. A few mistakes have obviously escaped the scrutiny of the editor, e.g. *Aloe boyleii* instead of *A. boylei, Sisyranthus huttonae* instead of *S. huttoniae* and *Beupleurum mundii* instead of *Bupleurum mundii* (even incorrect in the index).

A couple of misidentifications were spotted. *Phygelius capensis* does not, as far as present records show, occur in Natal. Presumably Mr. Trauseld collected *P. capensis* on the summit of the Drakensberg in Lesotho and assumed that the rather similar-looking *P. aequalis* growing in Natal represented the same species. *Trauseld* 162 (p. 35) is not *Moraea natalensis* Bak., but more probably *M. violacea* Bak. However, we need to see the type of *M. violacea* before this can be confirmed.

Several other points deserve mention. The map of the Natal Drakensberg on the front end paper would offend the purist cartographer: the name Drakensberg has been printed upside down i.e. in the original version and not just an error of reproduction. Mr. Trauseld states that *Philippia evansii* occurs on the summit of the Drakensberg as well as on the Little Berg. I have not seen *P. evansii* on the summit and doubt whether it has been collected there. It is surprising that *Watsonia socium, Moraea pubescens* and *Berkheya multijuga,* common species in the Drakensberg, were not depicted in the work.

In spite of the few imperfections mentioned, Mr. Trauseld's book is a praiseworthy effort and will be of immense value to all lovers of the flora of the Natal Drakensberg.

D. J. B. KILLICK.

Marguerite Gertrud Anna Henrici (photograph taken about 1930)

Boihalia, 10, 4: 503—508

Marguerite Getrud Anna Henrici (1892-1971)

by

M. D. Gunn

In November 1922 a Swiss scientist arrived in South Africa, a country she was to make her home for close on fifty years. Dr. Henrici was born on 22nd February, 1892, in the city of Basle, Switzerland, and obtained the Swiss matriculation certificate in 1912. After spending a period in France she enrolled in 1913 at the University of Basle where she studied botany, chemistry and zoology, eventually specializing in plant-physiology under Prof. Gustav Senn. In December 1917 she was awarded a doctor's degree *summa cum laude*.

The summer months of her later University years were spent at a small mountain laboratory which Senn had fitted up at Muottas Muraigl above Samaden in the Engadine Alps. Here, with her assistance, Senn worked during the vacations investigating the transpiration, respiration and assimilation of alpine plants. She became private assistant to Prof. Senn from 1919–20 and during 1920–22 she was a research worker in the botanical institute of the University.

At the beginning of her student career in 1913, she sat alongside a thickset bearded man in his middle forties. He was Dr. A. Theiler, later to become Sir Arnold Theiler, founder and director of the world-famed Veterinary Research Institute at Onderstepoort, near Pretoria. Dr. Theiler was home in Switzerland on a refresher course at the time. In after years, recounting her first meeting with the Veterinarian, she referred to it as "that important day in my life".

Dr. Theiler noted the young woman's progress, her capacity for work and her achievements as a research worker. When again in Europe in 1921, he visited Basle and invited her to come to South Africa to join his staff.

Lamsiekte—Armoedsvlakte

A disease among cattle known in South Africa as lamsiekte (botulism) had for long caused severe losses to stock farmers and baffled earlier investigators who had made a study of the disease. About 1912 the farm Armoedsvlakte, near Vryburg in the north-western Cape Province, an area particularly noted for lamsiekte, was taken over by the Veterinary Research Division as a field station for the investigation of the disease. In 1917, lamsiekte was particularly rife in South Africa and Theiler was asked to undertake the special task of lamsiekte research. Early in 1918, relieved of all administrative duties, he took up the post of Director of Lamsiekte Research at the Government farm Armoedsvlakte. By 1919 he was able to explain the cause of the paralysis in animals and how the disease could be prevented. A new field in the science of nutrition had been opened up by Theiler and his co-workers and it was to this field that Dr. Henrici was invited to come and work as a plant physiologist on the phosphorous deficiency of the grassveld.

From the University of Basle (its foundation dates from 1460), a centre of culture and refinement, she was placed in charge of the Armoedsvlakte field station, in an isolated, semi-arid region adjoining the Kalahari Desert. Not only can a greater contrast scarcely be imagined, but it was a precedent in South African Public Service history for a young woman, and a new-comer at that, to be put in charge of an out-station. She entered her new position with trepidation but, with the confidence of her chief, Sir Arnold Theiler, she immediately got down to work, showing the drive and determination for which she was noted throughout her career.

Her laboratory had been fitted up for veterinary research work but was ill equipped for a plant physiologist, and the only literature she had were her own private books and journals.

There was also the difficulty of language. She was fluent in German and French and had a working knowledge of English, but Afrikaans was new to her. In time she overcame this handicap to a certain degree but her reports required an understanding editor and, to the end of her days, she spoke both English and Afrikaans with a heavy German–Swiss accent.

Her first South African scientific paper, written in German, dealt with the transpiration of grasses in Bechuanaland and was published in Basle (1923). She then began a series of publications based on her research on natural pastures. This included work on chlorophyll, carbohydrates, phosphorous content of grasses and the cystine and sulphur content of Karoo shrubs and grasses, and in 1927 the University of South Africa awarded her a D.Sc. degree for a thesis on her plant physiological studies.

From July 1926 to December 1927 she was stationed near Ermelo in the eastern Transvaal in order to study the phosphorous content of highveld grasses, and the results of her investigations were published in the Report of the Director of Veterinary Services (1930).

The Veld Reserve, Fauresmith

Dr. Henrici was transferred from the Division of Veterinary Services to the Division of Plant Industry in 1929 and was appointed as Officer in Charge of the Veld Reserve at Fauresmith. Situated near Fauresmith in the south-western Orange Free State, the Reserve of some 70 ha (75 morgen) had been allocated by the Municipality in 1926 for the purpose of studying problems connected with the Karoo veld and, to some extent, pasture problems in other parts of the country.

Later, with an additional 25 ha, the land was purchased by the Government and Dr. Henrici was consulted on the planning and equipping of the laboratories and other buildings, including a residence which was to be her home for 29 years. In this small but up-to-date laboratory, with adequate reference books and periodicals, and assisted by competent technical staff, among whom Miss A. J. van der Walt and Messrs. P. E. Potter, A. F. J. Visagie and L. P. Meyer deserve special mention, Dr. Henrici entered a period of long and fruitful scientific research.

Not unnaturally, the conservative farming community did not immediately react favourably to her and her new approach to grazing problems. However, it is to her credit that she overcame these feelings of reserve and soon was regularly consulted on pasture matters. She was called in to visit neighbouring farms, attended their meetings and soon even gained the confidence of the farmers' wives, to the extent of being given their closely guarded cookery recipes.

She spent 1939 on vacation in Europe visiting plant physiological institutes and meeting some of her scientific correspondents.

During the 1940's she undertook a series of transpiration studies. Her techniques came in for some criticism and as a result of divergent opinions on the relative effects of indigenous and exotic trees on ground water resources, a certain amount of controversy followed.

On reaching the age of retirement on 21st February, 1948, Dr. Henrici continued to serve the Department of Agriculture in a temporary capacity. She continued with her work at the Veld Reserve, Fauresmith, until March 1957 when her services with the Department were finally terminated.

Dr. Henrici was not idle in retirement and had been urged to publish a book on Karoo bushes in both Afrikaans and English. She completed the manuscript which is as yet unpublished.

In spite of indifferent health at times, she lived actively and achieved a high scientific output. During the last two years of her life her health deteriorated and eventually she was accommodated in a home for the aged in Bloemfontein where she died on 28th July, 1971.

SOCIETIES AND AWARDS

In 1926 she was elected a member of the South African Association for the Advancement of Science and was a regular supporter of the Association. Their Journal was an outlet for many of her scientific papers. In 1937 she was President of Section C, her presidential address on the occasion being entitled "Transpiration of water supply of South African plants." In the 1950's she was the Vice President for the Orange Free State region.

She joined the South African Biological Society in 1926 and was awarded the Senior Capt. Scott Memorial Medal in 1935 for outstanding scientific achievements. She was an honorary member of Basle Botanical Society and in 1969 the University of Basle awarded her an honorary D.Sc., acknowledging its appreciation of her pioneer work in her field of research.

In 1971 the South African Association of Botanists honoured her by electing her an honorary life member of the Association.

No academic award she received charmed her as much as an illuminated address presented to her in 1968 by the farmers of Fauresmith district.

She amassed a herbarium of between 6,000 and 7,000 specimens, mainly of Karoo plants, and is commemorated in the names *Neohenricia* L. Bol. and *Salsola henriciae* Verdoorn.

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Bothalia, 10, 4: 509–516

The Genus Pithomyces in South Africa

by

W. F. O. Marasas* and Ingrid H. Schumann*

Abstract

Descriptions are given of South African isolates of *Pithomyces sacchari* (Speg.) M. B. Ellis, *Pithomyces chartarum* (Berk. & Curt.) M. B. Ellis and *Pithomyces* **karoo** Marasas & Schumann, sp. nov. *P. sacchari* and *P. chartarum* were isolated from *Medicago sativa* L. seed. *P. chartarum* was also isolated from dead leaves of *Lolium perenne* L. and *Sporobolus capensis* (Willd.) Kunth. plants from artificial pastures in the eastern Cape Province. *P. karoo* was isolated from stems of *Gnidia polycephala* (C.A. Mey.) Gilg and *Rhigozum trichotomum* Burch. from the Karoo, Cape Province and from *Avena sativa* L. stubble collected in the Orange Free State.

During the course of an investigation of the seedborne mycoflora of South African lucerne seed, *Pithomyces sacchari* (Speg.) M. B. Ellis and *P. chartarum* (Berk. & Curt.) M. B. Ellis were isolated from *Medicago sativa* L. seed produced in the Cape Province. *P. chartarum* and a new species, *P. karoo* Marasas & Schumann sp. nov., were isolated during the course of a mycological examination of several photosensitization syndromes in sheep in the Cape Province and Orange Free State.

Isolations were made by placing seeds or small pieces of plant tissue without surface sterilization on 1½% malt extract agar containing 100 mg/1 of sodium novobiocin and incubating at 25° C. Morphological descriptions were prepared of cultures incubated on 1½% malt extract agar (malt extract: 15 g; agar: 17 g; distilled water: 1 1) and potato-carrot agar (potatoes: 20 g; carrots: 20 g; agar: 17 g; distilled water: 1 1). All spore measurements are based on spores mounted in lactophenol and were made with the aid of an oil-immersion lens at a magnification of ×1250.

A key to and morphological descriptions of the South African species of *Pithomyces* are given below.

A. Conidia produced on potato-carrot agar and 1½% malt extract agar at 25° C predominantly smooth-walled or almost so, transverse septa 0–**2**–5, longitudinal septa 0–**0**–2, 9–**15**–28 × 4–**6**–10μ .... *P. sacchari*

Conidia produced on potato-carrot agar and 1½% malt extract agar at 25° C definitely rough-walled .... B

B. Conidia verruculose, transverse septa 0–**3**–5, longitudinal septa 0–**2**–3, 14–**20**–36 × 8–**12**–21μ .... *P. chartarum*

Conidia coarsely verrucose, transverse septa 0–**2**–5, longitudinal septa 0–**1**–3, 10–**22**–41 × 9–**15**–20μ .... *P. karoo*

1. **Pithomyces sacchari** (*Speg.*) *M. B. Ellis* in Mycol. Papers 76: 17 (1960); Hughes, Mycol. Papers 50: 70 (1953); Lakshminarasimhan & Rama Rao, Curr. Sci. 38: 74 (1969).

Figures: 1, 2.

Colonies on potato-carrot agar at 25° C are flatly appressed with little aerial mycelium, white, beginning to sporulate after 5 days and becoming tinged black with spores, particularly in the centre. On 1½% malt extract agar at 25° C colonies are woolly, white to olive-grey with the reverse smoky-grey to black, beginning to sporulate after 4 weeks. *Vegetative mycelium* composed of hyaline, smooth or coarsely verrucose, branching, septate hyphae, 1–3μ diam., and pale brown, smooth or verrucose hyphae, 4–7μ diam., often forming strands. *Conidiophores* arise laterally on the aerial mycelium at right angles to the parent hyphae, peg-like or cylindrical, hyaline to subhyaline, thin-walled, straight or curved, non-septate, 2–6 × 1,5–2,0μ,

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frequently densely clustered and bearing conidia in sporodochium-like masses, following spore dispersal the remains of the conidiophores appear as denticles along the hyphae (Fig. 2). *Conidia* arise singly as blown-out ends of each conidiophore, obovoid or clavate, brown, smooth-walled when immature and at maturity, rarely slightly roughened, with 1–5 transverse and 0–2 longitudinal septa, mostly 2 transverse and 0 longitudinal septa (Fig. 1; Table 1), slightly constricted at the septa 9–28 × 4–10μ (Table 2). Each conidium bears a short, hyaline basal frill which is the upper part of the conidiophore (Fig. 1).

Specimens examined: Cultures on 1½% malt extract agar and potato-carrot agar: PRE 44584, PRE 44585, PRE 44586 (Mycological Herbarium), isolated from *Medicago sativa* L. seed, Oudtshoorn, Cape Province, 1970.

Considerable difficulty was experienced in assigning these three South African isolates to a species. The spores are very similar to those of *P. sacchari* (Speg.) M. B. Ellis as described by Ellis (1960), and to those of *Sporidesmium bakeri* Syd. var. 1 as illustrated by Hughes (1953). The latter variety was considered a synonym of *P. sacchari* by Ellis (1960). The immature and mature conidia of the South African isolates are, however, predominantly smooth-walled on the agar media used and in this respect most closely resemble the conidia of *P. graminicola* Roy & Rai as described by Roy & Rai (1968). An examination of the type collection of *P. graminicola* (IMI 126508, on *Saccharum minja*, Banaras Hindu University Campus, India) revealed that the conidia of this fungus are smooth-walled, pyriform to clavate with 0–2 transverse and no longitudinal septa, 7–12 × 4–6μ (mostly 9 × 5μ) (Fig. 3). These spore characteristics are quite different from those of the three South African isolates (Fig. 1; Table 1, 2).

Dr. M. B. Ellis of the Commonwealth Mycological Institute, Kew, England, examined isolate PRE 44585 (= IMI 153452) and found that it produces: "short, obovoid, clavate and pyriform conidia with rough walls and longitudinal as well as transverse septa after 2 weeks on oat agar and I take this to be *Pithomyces sacchari*" (M. B. Ellis, personal communication).

P. sacchari has previously been recorded as a saprophyte on various plants from a number of countries (Hughes, 1953; Ellis, 1960) and has also been reported on leaves of *Saccharum officinarum* in Jamaica (Hudson, 1962) and in soil in India (Lakshminarasimhan & Rama Rao, 1969).

This is the first record of the occurrence of *P. sacchari* in the Republic of South Africa.

2. **Pithomyces chartarum** (*Berk. & Curt.*) *M. B. Ellis* in Mycol. Papers 76: 13 (1960); Hughes, Mycol. Papers 50: 66 (1953); Dingley, N.Z.J. Agr. Res. 5: 49 (1962).

Figure: 4

Colonies on potato-carrot agar at 25° C are flatly appressed with little aerial mycelium, white, beginning to sporulate after one to two weeks and becoming tinged black with spores. On 1½% malt extract agar at 25° C colonies are woolly or floccose, olive-grey in the centre with a white margin and a smoky-grey to black reverse, beginning to sporulate after one to four weeks, becoming black with a crust of spores, often giving rise to sectors which are more densely floccose than the rest of the colony and sporulate more heavily. *Vegetative mycelium* composed of thin-walled, hyaline, septate, smooth or verrucose, branching hyphae, 2–5μ diam., and dark-brown, smooth or verrucose, septate hyphae, 4–7μ diam., which may give rise to chains of verrucose, one-celled, dark-brown, intercalary chlamydospores, 10–20 × 8–18μ. *Conidiophores* arise laterally on the aerial mycelium at right angles to the parent hyphae, hyaline, thin-walled, straight or curved, non-septate or one-septate, 3–15 × 2–3μ, frequently clustered and bearing conidia in sporodochium-like masses. *Conidia* arise singly as blown-out ends of each conidiophore, at first fusoid, coarsely echinulate, hyaline

to pale brown, one-celled, becoming muriform and dark-brown. Mature conidia broadly ellipsoidal, rarely obovoid or clavate, dark-brown, verrucose, slightly constricted at the septa, with 2–5 transverse and 0–3 longitudinal septa, usually 3 transverse and 1–2 longitudinal septa in the central cells (Fig. 4; Table 1), 14–36 × 8–21μ (Table 2). Conidia become detached through fracture of the conidiophore wall and consequently each conidium characteristically bears a short, hyaline basal frill which is the upper part of the conidiophore (Fig. 4).

Specimens examined: Cultures on 1½% malt extract agar and potato-carrot agar: PRE 44581 (Mycological Herbarium), isolated from dead leaves of *Sporobolus capensis* (Willd.) Kunth., Robbehoek, Humansdorp Distr., Cape Province, September 1970, *Marasas* OP–9; PRE 44599, isolated from dead leaves of *Lolium perenne* L., Keokama, Humansdorp Distr., September 1970, *Marasas* OP–10; PRE 44582, isolated from *Medicago sativa* L. seed, Ladismith, Cape Province, June 1970, *Marasas* 306; PRE 44584, isolated from *M. sativa* seed, Oudtshoorn, Cape Province, July 1970, *Marasas* 366.

P. chartarum has previously been recorded as a saprophyte on paper and dead leaves and stems of many different plants from a number of temperate, sub-tropical and tropical countries, including Malawi, Rhodesia and Zambia (Hughes, 1953; Morris, 1956; Ellis, 1960; John, 1963; Sahni, 1966). This fungus has also been reported from Australia (Hore, 1960) and New Zealand (Dingley, 1962) where it is known to cause facial eczema in sheep; from the air on spore traps in Britain (Lacey & Gregory, 1962; Gregory & Lacey, 1964; Pawsey, 1964); from soil in Honduras (Goos, 1964) and Ontario (Barron, 1968); from wheat grains in Australia (Shipton & Chambers, 1966); from groundnuts and grasses in Texas (Taber, Pettit, Taber & Dollahite, 1968) and from human foodstuffs in Japan (Udagawa, Ichinoe & Kurata, 1970).

This is the first record of the occurrence of *P. chartarum* in the Republic of South Africa.

3. **Pithomyces karoo** *Marasas & Schumann* sp. nov.

Figures: 5, 6, 7, 8, 9, 10.

Hyphae ramosae, septatae, hyalinae vel brunneae, leves vel verrucosae, 2–6μ crassae. *Chlamydosporae* intercalares vel terminales, solitariae vel catenulatae, uni- vel bi-cellulares, leves vel verrucosae, fuscae, crassitunicatae, 5–15 × 5–10μ. *Conidiophora* singula ex apice lateribusque hypharum oriunda, simplicia, continua vel septata, cylindrica, recta vel flexuosa, hyalina, 3–25 × 2–4μ. *Conidia* singula in apice conidiophori oriunda, ellipsoidea, obovoidea, obpyriformia, clavata vel sarcinaeformia, brunnea vel fusca, verrucosa, septis constricta, septis 0–5 transversalibus et 0–3 longitudinalibus praedita, 10–41 × 9–20μ.

Colonies on potato-carrot agar at 25° C flatly appressed with little or no aerial mycelium, white, beginning to sporulate within 3 days and becoming tinged black with spores, particularly in the centre; at the edge of the petri dish old colonies sometimes develop a ring of downy white aerial mycelium or a brown ring of immersed spores that differ morphologically from the spores produced on the aerial mycelium. On 1½% malt extract agar at 25° C colonies are slow-growing, woolly or velvety, aerial mycelium in the centre Greyish Olive (Ridgway, Plate XLVI), beginning to sporulate within 3 days and becoming black in the centre with masses of spores that obscure the aerial mycelium; margin appressed with little or no aerial mycelium, white to Light Greyish Olive (Ridgway, Plate XLVI); colony reverse Cinnamon-Buff (Ridgway, Plate XXIX) to Vinaceous-Russet (Ridgway, Plate XXVIII) in the centre surrounded by a Light Yellowish Olive (Ridgway, Plate XXX) zone that becomes almost black in age and a white margin; young colonies of some single spore isolates produce an exudate that stains the surrounding agar Vinaceous-Russet (Ridgway, Plate XXVIII), but this exudate is not evident in old colonies. *Vegetative mycelium*

composed of several types of hyphae: hyaline, thin-walled, septate, branching, smooth or verruculose hyphae that are occasionally coarsely warted, 2–6μ diam., and brown, multiseptate, smooth or verruculose hyphae that are often aggregated into strands, composed of cylindrical or ellipsoidal cells, 5–15 $\times$ 3–6μ; the hyaline as well as brown hyphae occasionally give rise to intercalary or terminal, one- or two-celled, smooth or verruculose, brown, thick-walled, ellipsoidal or ovoid to subglobose chlamydospores that are solitary or produced in short chains, 5–15 $\times$ 5–10μ (Fig. 10). *Conidiophores* arise laterally on the aerial mycelium at right angles to the parent hyphae, hyaline, thin-walled, straight or curved, usually non-septate but occasionally with one or two septa, short and cylindrical, 3–25 $\times$ 2–4μ (Fig. 6); occasionally long, flexuous, septate, hyaline, thin-walled hyphae indistinguishable from vegetative hyphae, terminate in conidia (Fig. 7); following spore dispersal the remains of the conidiophores appear as denticles along the hyphae. *Conidia* aleuriospores that arise singly as blown-out ends of each conidiophore, at first fusoid, hyaline to straw-coloured, coarsely verrucose to warted, one-celled, becoming muriform and dark brown (Fig. 6). Mature conidia mostly ellipsoidal with broadly rounded ends occasionally obovoid, obpyriform, clavate, cruciform, sarciniform or curved, dark brown, thick-walled, coarsely verrucose to warted with obtusely rounded warts up to 2μ long and 2μ wide at the base, conspicuously constricted at the septa, with 0–5 transverse and 0–3 longitudinal septa, occasionally sarciniform with numerous transverse, longitudinal and oblique septa, mostly with 2 transverse and 1 or 2 longitudinal septa in the central and/or terminal cells (Figs. 5, 8; Table 1), 10–41 $\times$ 9–20μ, mostly 20–24 $\times$ 15–16μ, including warts, width measured in the broadest part (Table 2); conidia become detached through fracture of the conidiophore wall and consequently each conidium bears a short, hyaline basal frill which is the upper part of the conidiophore (Fig. 5). *Immersed conidia* are produced in the agar on slender, thin-walled, hyaline conidiophores that are poorly differentiated from the thin-walled, hyaline, immersed hyphae, 5–15 $\times$ 1,5–2,5μ; hyaline, subhyaline to light brown, thick-walled, smooth or verruculose, ellipsoidal with broadly rounded ends or obovoid, obpyriform or cruciform, one- to four-celled, occasionally sarciniform and multi-celled, mostly two- or three-celled, 10–20 $\times$ 10–15μ (Fig. 9).

Specimens examined: Cultures on 1½% malt extract agar and potato-carrot agar: PRE 44605 (Holotype), isolated from dead stems of *Gnidia polycephala* (C.A. Mey.) Gilg, Riekertsfontein, Colesberg Distr., Cape Province, February 1970, *Marasas* OP-11; PRE 44606, isolated from *Avena sativa* L. stubble, Rusthof, Heilbron Distr., Orange Free State, March 1971, *Marasas* OP-12; PRE 44607, isolated from living stems of *Rhigozum trichotomum* Burch., heavily infested by scale insects and a sooty mould, Welverdiend, Hopetown Distr., Cape Province, March 1971, *Marasas* OP-13.

Type specimens in the form of dried-down cultures on agar have been deposited in the National Herbarium, PRE (Mycological Herbarium), Department of Agricultural Technical Services, P.O. Box 994, Pretoria, South Africa. A culture of the type strain (PRE 44605) has also been deposited in the Commonwealth Mycological Institute, Kew, England, under accession number IMI 155881.

P. karoo differs from *P. chartarum* in having coarsely verrucose conidia that predominantly have two transverse septa and are much more irregular in shape. The morphologically dissimilar immersed conidia found in cultures of *P. karoo* on PCA were not found in cultures of *P. chartarum*. The significance of these immersed conidia can not be interpreted at present. Marked differences between the spores of *Trichocladium opacum* (Corda) Hughes produced on aerial hyphae and those on immersed mycelium were also noted by Kendrick & Bhatt (1966).

A study is in progress to determine the effects of temperature on growth, sporulation and spore morphology of the South African *Pithomyces* isolates.

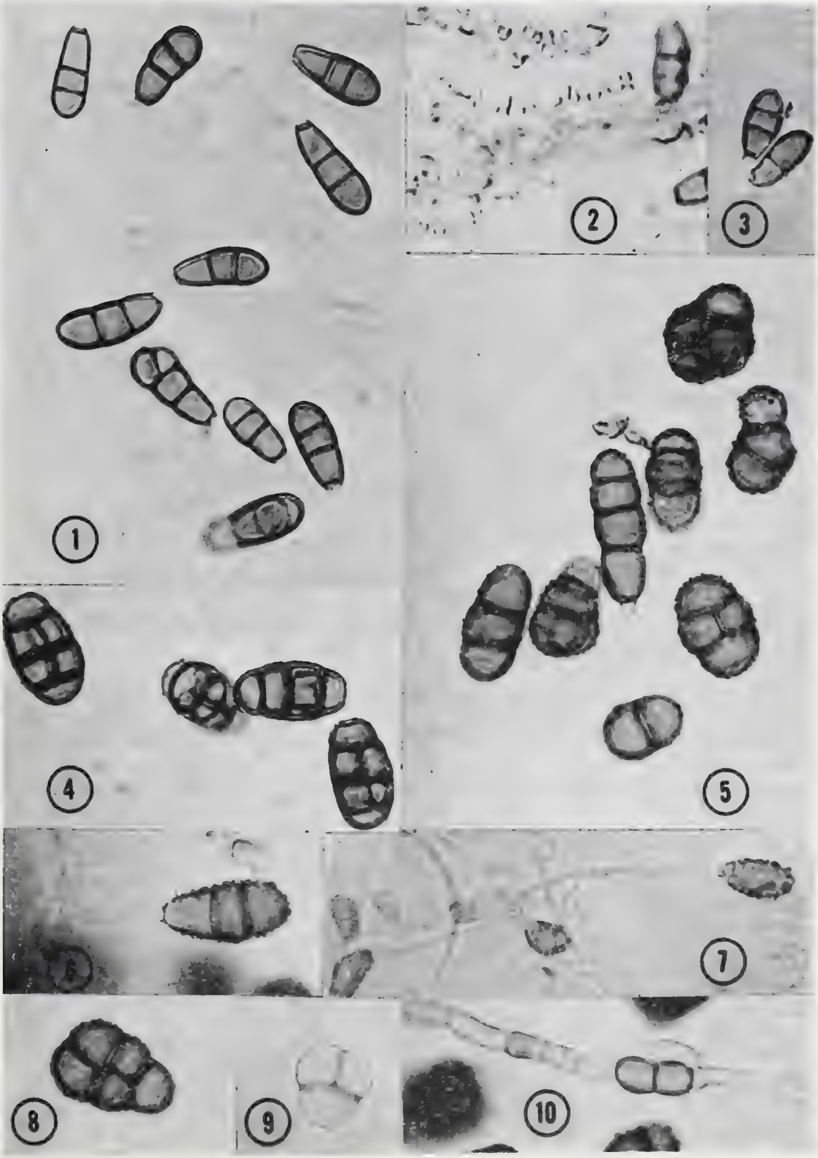

FIG. 1–2.—**Pithomyces sacchari.** Fig. 1, mature conidia. Fig. 2, denticulate hypha (1 000).
FIG. 3.—**Pithomyces graminicola** (Type), mature conidia (× 1 000).
FIG. 4.—**Pithomyces chartarum,** mature conidia (× 1 000).
FIG. 5–10.—**Pithomyces karoo** (Type). Fig. 5, mature conidia. Fig. 6, immature conidium on hyaline conidiophore. Fig. 7, aerial hypha terminating in a conidium. Fig. 8, mature conidium with a longitudinal septum in the terminal cell. Fig. 9, immersed conidium. Fig. 10, intercalary chlamydospore (× 1 000).

TABLE 1.—Spore septation of *Pithomyces* species[a].

Species & isolate (PRE)	Septation (% of spores[b])																	
	Potato-carrot agar									1½% malt extract agar								
	Transverse					Longitudinal				Transverse					Longitudinal			
	1	2	3	4	5	0	1	2	3	1	2	3	4	5	0	1	2	3
P. chartarum 44581	0	0	96	4	0	10	36	54	0	0	0	98	2	0	8	36	56	0
P. chartarum 44599	0	4	96	0	0	14	30	56	0	0	0	100	0	0	10	37	56	0
P. chartarum 44582	0	0	96	4	0	18	32	50	0	No spores					No spores			
P. chartarum 44583	0	0	70	24	6	8	30	62	0	0	20	70	8	2	6	44	48	2
P. sacchari 44584	8	60	26	4	2	74	20	6	0	No spores					No spores			
P. sacchari 44585	20	44	30	6	0	92	8	0	0	No spores					No spores			
P. sacchari 44586	26	48	24	2	0	90	10	0	0	No spores					No spores			
P. karoo 44605	34	58	8	0	0	42	38	20	0	22	68	10	0	0	30	44	26	0
P. karoo 44606	40	50	10	0	0	14	52	34	0	26	56	12	4	2	20	52	26	2
P. karoo 44607	36	48	12	4	0	6	46	46	2	32	60	6	0	2	18	40	38	4

[a] Cultures incubated at 25° C for 21 days.

[b] Values based on 50 spores mounted in lactophenol.

TABLE 2.—Spore measurements of *Pithomyces* species[a]

Species & isolate (PRE)	Spore size (μ)[b]					
	Potato-carrot agar			1½% malt extract agar		
	Range	Average	Mean	Range	Average	Mean
P. chartarum 44581	16–25 × 8–14	20,1 × 11,1	20 × 11	18–26 × 10–13	20,3 × 11,2	20 × 12
P. chartarum 44599	14–25 × 8–15	20,3 × 11,7	21 × 12	15–24 × 9–14	19,9 × 11,7	19 × 12
P. chartarum 44582	17–26 × 9–15	20,3 × 12,5	20 × 12	No spores		
P. chartarum 44583	19–30 × 9–16	22,6 × 12,8	21 × 12	18–36 × 12–21	25,9 × 16,8	25 × 16
P. sacchari 44584	10–22 × 5–10	15,7 × 6,5	15 × 6	No spores		
P. sacchari 44585	9–28 × 4–8	16,8 × 5,8	14 × 6	No spores		
P. sacchari 44586	9–25 × 5–8	15,1 × 6,1	16 × 6	No spores		
P. karoo 44605	10–27 × 9–17	19,8 × 12,9	20 × 15	16–31 × 12–19	22,3 × 14,3	23 × 16
P. karoo 44606	13–31 × 11–17	19,9 × 14,8	22 × 15	13–36 × 11–19	23,5 × 15,1	24 × 15
P. karoo 44607	16–41 × 11–17	22,0 × 14,8	21 × 15	13–41 × 10–20	21,1 × 15,0	21 × 15

[a] Cultures incubated at 25° C for 21 days.

[b] Values based on 50 spores mounted in lactophenol.

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Studies of Wood-rotting Fungi. II. Basidiomycetes from the Wood-preservative Field Exposure Test Plot at Kruisfontein

by

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ABSTRACT

In a survey of the fungi associated with decays of treated and untreated wood specimens partly interred in a wood-preservative field exposure test plot, 13 species of Basidiomycetes were identified from 120 test specimens. Basidiomycete mycelia isolated from a further 51 specimens could not be identified due to the absence of fruit-bodies or lack of matching descriptions of cultural characters. A further 179 did not yield Basidiomycete mycelia when cultured. *Paxillus panuoides* and *Stereum hirsutum* were the most common species. Species of lower Hymenomycetes were more frequently isolated than polypores.

The named species of fungi and unnamed mycelia are listed together with their hosts. Seven species, viz. *Neamatoloma fasciculare*, *Odontia bicolor*, *Paxillus panuoides*, *Peniophora aspera*, *Peniophora cinerea*, *Peniophora tenuis* and *Polyporus gilvus* are described in pure culture.

INTRODUCTION

A plot for testing the efficacy of wood-preservatives against decay in the field was established at Kruisfontein Plantation near Knysna, Cape Province, by the Department of Forestry in 1946 as one of three field exposure test plots. Two others, one at Pienaarsrivier, Transvaal and one in Durban Harbour, Natal, were established for field exposure tests of wood-preservatives against termite attack and marine borers, respectively.

The test plot at Kruisfontein consists of a rectangular fenced-in area, half an acre (0,202 ha) in extent, situated on a slight rise with a northerly aspect and grey, gritty loam soil, cleared of all trees and woody shrubs (Fig. 1). The plot is divided into four quarters for experimental purposes and is laid out in exactly the same way as the plot at Pienaarsrivier which had already been described by Coaton (1946) and Krogh (1947).

The specimens for testing consist of treated billets of *Eucalyptus saligna* and *Pinus patula*, 45 cm long and 7–10 cm in diameter, saplings of *E. saligna* of the same length but about 3 cm in diameter, and 2,5 cm square stakes of *Pinus patula* wood. Eight specimens of each type of stake and billet are treated and interred in the erect position to a depth of about 25 cm so that a total of 32 specimens treated to a particular loading of each type of preservative are under test simultaneously, eight specimens in each quarter of the plot. In addition, billets of 50 x 5 x 2 cm of different species of untreated wood, with separate billets for heartwood and sapwood, are interred along the periphery of the plot to determine their natural durability. The layout of the experiment and treatments of the specimens have been described by Krogh (1947).

This study was undertaken to determine the species of fungi which are associated with decay of the specimens under test. It was furthermore attempted to determine whether particular species of fungi are constantly associated with decayed specimens which had been treated with any particular preservative. Any such association may indicate the possible value of that fungus as a test organism for use in laboratory tests of timber preservatives. Furthermore, the termite and marine borer fauna of the respective field exposure test plots had been surveyed (Coaton, 1946; Krogh, 1958) and it was thought desirable that a similar survey of the wood-decaying fungi of the plot at Kruisfontein should be carried out.

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This survey was limited to the Basidiomycetes only. It has been shown by other workers (Merrill & French, 1966; Käärik, 1967) that Hyphomycetes play an important role in the early colonization of untreated wood in the soil or in the detoxification of certain wood-preservatives (Lyr, 1962; Madhosing, 1961). These organisms are, however, replaced by Basidiomycetes which cause extensive white or brown rots (Henningson, 1967a & b; Merrill & French, 1966) whilst some Basidiomycetes have also been found among the early invaders of treated poles in contact with soil (Käärik, 1967). Because of the method used for collecting specimens for study, however, the Hyphomycetes and Ascomycetes associated with the decayed specimens had to be ignored for the purpose of this investigation.

In the present paper the species of Basidiomycetes that were identified, are listed together with the test specimens on which they occurred. Unidentified mycelia arranged in groups according to their cultural characters, are also listed together with the specimens on which they occurred. Named isolates which have not been reported in culture from South Africa before, are described and illustrated whilst the occurrence and importance of other named species, previously described in culture from South Africa, are discussed.

Methods and Materials

The specimens under test were examined periodically as described by Krogh (1947), usually in late autumn. All specimens were examined visually for the presence of fruit-bodies of decay fungi which would allow their identification. The specimens were then removed from the soil and examined for signs of decay. Specimens of which more than 50% of the cross-sectional area was decayed, were regarded as failures and discarded. These discarded specimens were collected for the isolation of fungi.

The specimens were split lengthwise by means of a circular saw to expose the decayed areas. Small blocks of about 1 cm^3 were cut from the sound wood adjacent to the decay. These blocks were then split by means of a chisel and surface sterilized by dipping them briefly in 70% alcohol and flaming. After flaming they were placed on 1,5% Difco malt extract plates solidified with 1,5% Difco agar. These plates were incubated at 24° C and fungal mycelium appearing on the blocks or plates was transferred to fresh plates of the same medium for further growth.

When specimens could not be treated immediately upon receipt, large sections of the specimens were cut out and placed on damp sterile sand in damp chambers in order to keep the fungi alive for isolation later.

Fungi of which fruit-bodies were present on the specimens, were identified on the characters of the fruit-bodies. Cultures were made by transferring small pieces of tissue from freshly exposed, broken surfaces of the fruit-bodies by means of fine-pointed, sterile forceps to plates of 1,5% Difco malt extract agar. These cultures were used for comparison with other mycelia isolated from the specimens to determine their identity.

Fungi isolated in pure culture only were grown on 1,5% Difco malt extract agar in the dark at 24° C for six weeks and examined both macroscopically and microscopically at weekly intervals according to the methods described by Nobles (1948; 1965) and Van der Westhuizen (1958; 1971). Their characters in pure culture were compared with existing descriptions of species of which these characters are known in order to determine their identity.

The fungi were tested for the production of extra-cellular oxidase enzymes by growing them on 1,5% Difco malt agar to which had been added 0,5% tannic acid and 0,5% of gallic acid respectively as described by Van der Westhuizen (1958).

Mycelia which could not be identified from descriptions of known species, were inoculated onto a sawdust-maizemeal-malt extract mixture in order to induce fructification on blocks of *Pinus patula* wood according to a method described by Matters & Da Costa (1958).

Results

A total of 171 Basidiomycetes were found as fruit-bodies or isolated as mycelia in pure culture from the 350 specimens of decayed wood examined. Of these fungi, 120 were identified and named from fruit-bodies on the specimens or from their characters in pure culture. The named fungi as well as the specimens on which they were found and their frequence of occurrence, are listed in Table 1.

It was soon evident, that very few fruit-bodies were to be seen on the specimens during the annual inspections. Fruit-bodies of *Stereum hirsutum* were most abundant whilst fruit-bodies of *Peniophora cinerea*, *Peniophora setigera* and *Lenzites sepiaria* were occasionally seen. Most specimens, however, never showed fruit-bodies although many of them were found to be almost completely decayed.

In the course of this investigation it also became evident that no decay fungi were present in many of the decayed specimens despite repeated attempts to isolate them in culture. This was especially noticeable in the 25 mm square *Pinus patula* sticks. Many of these produced moulds only, when cultured, and *Trichoderma viride* proved to be a most important component of the mould flora. In specimens with a diffuse decay, this mould mostly grew out from the inoculum to the exclusion of all others.

From the results in Table 1, it is evident that *Odontia bicolor*, *Paxillus panuoides*, *Peniophora tenuis* and *Stereum hirsutum* are the species most frequently isolated from these specimens. *Neamatoloma fasciculare*, *Peniophora aspera*, *Peniophora cinerea*, *Lenzites sepiaria* and *Schizophyllum commune* were isolated less frequently. Among the named isolates, species of Thelephoraceae and Agaricaceae were thus most frequently isolated, rather than members of the Polyporaceae. Of these species, *Lenzites sepiaria* and *Paxillus panuoides* were isolated from softwood specimens only whilst *Neamatoloma fasciculare*, *Polyporus gilvus*, *Schizophyllum commune* and *Stereum hirsutum* were found on hardwoods only. The other species occurred on both hardwood and softwood specimens.

Most of the fungi were isolated from untreated specimens. This is to be expected since the lack of preservative treatment would allow their more rapid attack by fungi. But *Paxillus panuoides*, the most frequently isolated species, occurred very frequently on specimens which had been treated with preservatives. Since this species is known to be very sensitive to timber preservatives (Cartwright & Findlay, 1958) it's presence on the treated specimens indicate that the different preservatives had been rendered ineffective in the wood through leaching, detoxification or other similar causes during the period of duration of the test.

Besides the fungi listed in Table 1, 51 more fungi of which the cultural characters could not be matched with any existing descriptions, were isolated but their identity could not be determined. These isolates, together with their culture numbers and timber specimens on which they were found, are listed below in Table 2. The mycelia are arranged in groups according to their major cultural characters as arranged by Nobles (1958).

From the results presented in Table 2, it is clear that the majority of unidentified fungi isolated from the specimens, in culture form undifferentiated nodose-septate hyphae only. A larger number of these gave positive reactions when tested for extracellular oxidase, than gave negative reactions. Only four cultures were found in which fibre hyphae were present as well, whilst 8 cultures were found with nodose-septate hyphae with irregularly thickened walls. Most of the remaining cultures did not display any differentiated structures and few mycelia with swellings on the nodose-septate hyphae or other special structures were present. Only one culture with simple-septate advancing hyphae and clamped septa on the older hyphae, was found.

The majority of these unidentified mycelia were also isolated from specimens of untreated timber, either as untreated controls or specimens tested for natural durability.

These cultures all displayed characters which allowed their inclusion into the groups proposed by Nobles (1958). These characters however could not be matched with existing descriptions of known species so that their identity could not be determined.

Descriptions of Cultures

A number of decay fungi of which the cultural characters are not well known, were found in this investigation. Some of them are not known to be widely distributed in South Africa and the characters of the South African forms in culture have not been described before. For these reasons descriptions of their cultural characters are given below.

Naematoloma fasciculare (*Huds. ex Fr.*) *Karst.*

Growth characters (Fig. 4)

Growth is moderately fast, the colony reaching a radius of 36 mm in 2 weeks and covering the plate in 3 weeks. Advancing zone even, appressed for 1–2 mm, hyphae then raised. Mat thin woolly, with small plumules of radiating hyphae, somewhat farinaceous at the side of the dish. The plumulose areas develop into thin, felty, rhizomorphic strands which merge and diverge to form an irregular, elongated diamond-shaped pattern on the surface. The mat is white and remains so but specks of "hazel" "pinkish buff" and "cinnamon buff" appear on the surface under the mat after 2–3 weeks and gradually enlarge in size. The reverse bleaches slowly after about 2 weeks and a faint musty odour is given off. On gallic acid and tannic acid media, strong diffusion zones are formed and colonies of 16 mm and 22 mm in diameter resp. are formed after 7 days.

Hyphal characters.

Advancing hyphae: hyaline, more or less straight, branching, thin-walled, with deeply staining contents, septate, with simple clamps at the septa, often branching opposite the clamps, 2,0–4,0 μ in diameter (Fig. 5).

Aerial mycelium: (i) hyphae as in the advancing zone; (ii) hyphae as in the advancing zone but aggregated into rhizomorphic strands and often agglutinated by brown, resinlike material (Fig. 7); (iii) dendrophyses yellowish, thin-walled, curved, with short, lateral branches 4–6μ long, arising at right angles from the curved part, slightly widened and with deeply staining contents at first but later with dark-coloured, slightly thickened walls and brown contents, up to 100μ long (Fig. 6).

Submerged mycelium: hyphae as in the advancing zone.

Naematoloma fasciculare causes a white rot of hardwoods.

This fungus was described in culture by Zycha & Knopf (1966). The characteristics displayed by the South African isolates, agree very well with their description. The isolates in the present study were all very much alike displaying the strands or fibrils of hyphae which give the mat the appearance of "a wet pelt" (Zycha & Knopf, 1966). The brown, widened, curved hyphal structures with short, lateral projections (Fig. 6) designated as "dendrophyses" by Zycha & Knopf (1966), are very striking in microscopic mounts and together with the characteristic appearance of the mat, are useful diagnostic features for the recognition of cultures of this species.

N. fasciculare was isolated from hardwood specimens only on which it causes white rot. Its association with white rot agrees with its positive reaction for extracellular oxidase enzymes in culture as noted both here and by Zycha & Knopf (1966). Doidge (1950) recorded this fungus on *Pinus* stumps and other unspecified species of wood in the southernmost parts of the country and the present author found it also on *Eucalyptus* in the vicinity of the testing plot. It has been recorded on various conifers in Great Britain (Cartwright & Findlay, 1958) and is reported to be one of the commonest fungi participating in the decomposition of oak roots in the U.S.S.R. (Chastukhin & Nikolaevskaya, 1962).

Odontia bicolor (*Alb. & Schw. ex Fr.*) *Bres.*

Growth characters (Fig. 8)

Growth is moderately rapid to slow, the mat reaching a radius of up to 35 mm after one week and covering the plate in three to six weeks. Advancing zone even to slightly bayed, appressed for short distance then raised. Mat thin, white, appressed, downy to fine woolly at first and with a combed appearance, later developing thin, branching and anastomosing lines of more compact mycelium which radiate out from the inoculum. After 2–3 weeks indefinite, concentric zones of raised mycelium, 20–30 mm wide, which end abruptly on zones of mycelium more closely appressed to the agar, may develop in some isolates.

Reverse bleaching slowly, becoming milky white. No odour is emitted. On gallic acid medium a strong diffusion zone of up to 40 mm in diameter is formed without growth taking place. On tannic acid medium strong diffusion zones of up to 50 mm and colonies of up to 40 mm in diameter are formed.

Hyphal characters.

Advancing mycelium: hyphae hyaline, thin-walled with deeply staining contents, nodose-septate, branching often from the clamps, 2,0–5,0μ in diameter (Fig. 9).
Aerial mycelium: (i) hyphae as in the advancing mycelium, often aggregated into thin strands; (ii) cystidia numerous, each consisting of a short stalk up to 15μ long, arising as a lateral branch of a trailing hypha, terminally expanded into a subglobose vesicle 5–10μ in diameter, and surmounted by a cap of large jagged crystals, the cap 12–25μ in diameter (Fig. 10); (iii) oidia present in some isolates, 3–10 x 1,5–3μ.
Submerged mycelium: hyphae as in the advancing zone.

This fungus was isolated from 14 specimens of different species of hardwood, both treated and untreated with preservative, and one of softwood. On all specimens it caused a white, somewhat stringy rot.

In cultural characters, the South African isolates agree very well with the description of *Odontia bicolor* by Nobles (1953), and with two cultures of this species received from Dr. J. H. Ginns, Ottawa. The texture of the mat, positive reaction for extracellular oxidase enzymes, and the capitate cystidia with caps of large, angular crystals, allow the easy recognition of this fungus in culture.

Nobles (1953) reported that *O. bicolor* causes a decay of considerable importance in the heartwood of the butt and roots of a number of broad-leaved and coniferous trees. In a survey by the Canada Department of Agriculture (1952) *O. bicolor* was listed as one of the three important white rot fungi which caused 85% of the decay of *Abies lasiocarpa* in the Prince George Forest District. This importance was emphazised by the work of Smith (1963) who listed *O. bicolor* in association with root rot of *Abies* spp. Basham & Morawski (1964) listed *O. bicolor* as one of 23 species which cause 91% of decay losses of timber species in Ontario, but considered it to be of economic importance in balsam fir and spruce only. Duncan & Lombard (1965) listed *O. bicolor* as one of the species frequently isolated from gymnospermous wood in the United States. Harmsen (1967) described *O. bicolor* as one of the important fungi capable of attacking structural timber treated with preservative.

Few previous records of the occurrence of *O. bicolor* in South Africa exist. Doidge (1950) has no record of it but Talbot (1958) described two collections from South Africa. In view of the frequent occurrence of *O. bicolor* on the test specimens from Kruisfontein and the importance accorded to it in overseas reports, *O. bicolor* must be regarded as a much more important agent of decay of timber in contact with soil in South Africa than had been generally realized before.

Paxillus panuoides *Fries.*

Growth characters (Fig. 11)

Growth is slow to very slow, the mat reaching a radius of 30 mm after 3 weeks while the plates are seldom covered at 6 weeks. The margin is even to bayed with hyphae raised to the limit of growth. The mat is coarsely woolly, raised, consisting of

loosely intertwined rhizomorphic strands of mycelium radiating out from the inoculum. Mat at first forming a yellowish ball on the inoculum but then grows out over the agar as "light buff" to "cartridge buff" strands often with tinges of reddish purple or violet developing on the inoculum.

The reverse darkens, the dark zone extending well beyond the mat into the agar within one week after inoculation of the plates. No odour is emitted.

On gallic acid and tannic acid media dark diffusion zones are formed. Growth, up to 5 mm in one week on gallic acid, none or trace only on tannic acid.

Hyphal characters.

Advancing mycelium: hyphae hyaline, thin-walled, nodose-septate, branching sparingly opposite the clamp connections, 1,5–5,0μ in diameter (Fig. 12).

Aerial mycelium: hyphae as in the advancing zone, often aggregated into strands and with walls frequently yellow (Fig. 13, 14).

Submerged mycelium: hyphae as in advancing mycelium but often wider, up to 7μ in diameter and more frequently branched.

Paxillus panuoides was associated with brown rot in stakes of *Pinus patula*, some of which had been treated with wood preservatives.

Paxillus panuoides has been described in culture by Findlay (1932) and Siepmann & Zycha (1968). The South African isolates described here agree very well with these descriptions and with two cultures of this species obtained from Dr. Siepmann. The South African isolates were grown in culture with some difficulty as they preferred low incubation temperatures, 16–20° C, their growth being completely inhibited at 25° C while some growth still occurred at 10° C. This, together with the fact that this species requires an acid medium (Findlay, 1932) made isolation possible only after the species had been identified from a fruit-body which developed on a block of wood cut from a decayed test specimen and kept in a damp chamber. Cultures of this species may however be recognized quite readily by the woolly, dull yellow mat, with tinges of violet near the inoculum.

The brown rot caused by *P. panuoides* is not in agreement with the positive oxidase reaction shown by cultures of this fungus when grown on gallic acid and tannic acid media. The reaction is weak on both media and the darkening in colour of the media is possibly due to the brown pigment produced by the fungus diffusing into the medium.

Paxillus panuoides is well-known as a cause of brown rot of coniferous wood (Southam & Ehrlich, 1950; Cowling, 1957; Cartwright & Findlay, 1958; Duncan & Lombard, 1965). The difficulty with which this fungus is isolated in pure culture, also experienced by Siepmann & Zycha (1968), may have a negative influence on observations of its importance as the cause of decay. In the present study it was observed on 26 different test specimens but only five isolates were obtained in pure culture, an experience which supports the previous remarks.

Paxillus panuoides was found most frequently of all species, named and unnamed, on the test specimens. This in itself is surprising as Doidge (1950) lists only three records of its occurrence in South Africa, none of them from the Knysna district. Cartwright & Findlay (1958) state that this fungus is extremely sensitive to wood-preservatives. Its presence on the specimens that had been treated with preservatives indicates then that the concentration of these preservatives must have been reduced to extremely low values in the specimens before they were attacked by this fungus. Its frequent occurrence and constant association with extensive brown rot of these test specimens, are contrary to Henningson's (1967c) observation that fungi with temperature optima below 25° C have low decay ability.

Peniophora aspera (*Pers.*) *Sacc.*

Growth characters (Fig. 15)

Growth is slow, the colony reaching a radius of 10 mm after one week, but does not cover the plate after 6 weeks. Advancing zone even, mat thin, hyphae raised to limit of growth. Mat at first downy, hyaline-white, gradually becoming slightly more compact to thin woolly. After 3 weeks more compact, small patches of mycelium appear, scattered over the older parts of the mat and gradually developing into more compact lumps of mycelium.

The reverse remains unchanged and a faint mushroomy odour is given off. No growth occurs on gallic acid and tannic acid media but small, weak diffusion zones are formed after 7 days.

Hyphal characters.

Advancing mycelium: hyphae hyaline, simple or branching, nodose-septate with large clamps at the septa, thin-walled, with deeply staining contents, 2,5–4,5μ in diameter (Fig. 16).

Aerial mycelium: (i) hyphae as in the advancing zone; (ii) chlamydospores hyaline, thick-walled, globose or sub-globose, terminal 6,0–9,0μ in diameter.

Submerged mycelium: hyphae as in the advancing mycelium.

Peniophora aspera had apparently not been described in culture before and, despite its world-wide distribution, had not received much attention as a decay fungus. In culture it displays no character which might distinguish it from the many other species which form slow-growing, white mycelia lacking in distinguishing features. Not one of the cultures examined produced the characteristic septate cystidia which characterize fruit-bodies of this species (Slysh, 1960).

Isolation of this species from six specimens of treated and untreated wood, indicate that it may be of more importance as a decay organism or detoxicating agent of certain types of wood-preservative than had been suspected hitherto. This view is supported to some extent by the report by Bergman, Nilson & Jerkeman (1970) who found *P. aspera* as one of the white-rot fungi at test points in chip piles where temperatures had not exceeded 40° C. In these piles the effect of *P. aspera* was not very marked at the points of isolation. This was thought to be due to inhibition by *Trichoderma viride* because laboratory tests had shown *P. aspera* to be capable of causing high losses in dry mass of test blocks.

Peniophora cinerea (*Fries*) *Cooke.*

Growth characters (Fig. 17)

Growth is moderately rapid to rapid, the mat reaching a radius of up to 45 mm in one week and covering the plate in 2–3 weeks. Margin even with the hyphae raised to limit of growth. Mat woolly at first, white, with sectors of dense, more felty mycelium becoming gradually more dense with age and remaining so or developing irregular, scattered patches of dense, finely farinaceous mycelium over the surface and sides of dish, white at first and remaining so, or, becoming "warm buff" but soon changing to "sayal brown", later darkening to "warm sepia" or "bister". Mycelium on the sides of the dish form white, felty lumps which soon change colour to "warm buff" or "pale ochraceous salmon" and enlarge, coalesce and gradually darken to "russet", "warm sepia", "mars brown" or "bister", oozing droplets of dark, reddish-brown liquid.

The reverse is bleached at first but darkens later due to the diffusion of a brown pigment. No odour is given off. On gallic acid and tannic acid media, strong diffusion zones up to 85 mm in diameter and colonies of up to 80 mm in diameter are formed in one week.

Hyphal characters.

Advancing mycelium: hyphae hyaline, branching, thin-walled with deeply staining contents, nodose-septate, 2,0–4,5μ in diameter (Fig. 18).

Aerial mycelium: (i) hyphae as in the advancing mycelium; (ii) nodose-septate hyphae with brown, thickened walls, often with swellings and short, lateral projections and encased in drops of brown resin-like material which apparently bind them together in the dark brown aerial parts of the mat (Fig. 19).

Submerged mycelium: hyphae as in the advancing mycelium.

Cultures of *Peniophora cinerea* lack special structures which may be of value in establishing their identity. They lack the conical, thick-walled, heavily incrusted cystidia which are present in the carpophores of this species (Slysh, 1960). The brownish, nodose-septate hyphae embedded in droplets or sheaths of brown resin-like material in the brown-coloured, felty patches of the otherwise white, woolly-felty mat together with the rapid growth rate and strong positive reaction when tested for extra-cellular oxidase enzymes, may however serve to distinguish cultures of *P. cinerea* from those of otherwise similar species.

Peniophora cinerea is not well known from previous records of its occurrence in South Africa. Doidge (1950) lists only three collections. In the present investigation however it was recorded on ten specimens affected by white rot, which includes both treated and untreated hardwoods and softwoods. Very little is known about its importance as the cause of decay of wood however. It was not listed in the United States by Cowling (1957) and Duncan & Lombard (1965) but Nilsson (1965) found this species to be one of the important Basidiomycetes causing decay of birch chip piles in Sweden. Its relatively frequent occurrence on test specimens from Kruisfontein, may indicate that this fungus has more importance as a wood destroyer than had been generally realized.

Peniophora tenuis (*Pat.*) *Massee.*

Growth characters (Fig. 20)

Growth moderately slow to slow, the mat reaching a radius of 30–45 mm after 2 weeks and covering the plates in 4 to 6 weeks. Advancing zone even, thin, appressed with thin, sparse, radiating strands of hyphae. The mat is thin, downy at first and somewhat farinaceous, white, with thin, sigmoid strands of mycelium radiating from the inoculum towards the margin. The mat gradually thickens towards the inoculum where it becomes thick, felty. Minute droplets of clear liquid appear on the mat especially on the rhizomorphic strands. The mat gradually thickens with time.

The reverse is bleached but no odour is given off. On gallic and tannic acid media no growth or a trace of growth takes place but fairly strong diffusion zones of about 20 mm in diameter are formed on both media.

Hyphal characters.

Advancing mycelium: hyaline, branching thin-walled, nodose-septate, with simple clamps at the septa, 2,0–5,0μ in diameter (Fig. 25).

Aerial mycelium: (i) hyphae as in the advancing mycelium; (ii) cystidia hyaline, elongate-ovoid, to cylindrical (Fig. 22, 23); (iii) capitate cystidia globose 5–8μ in diameter, with deeply staining contents, pedicellate on clamped hyphae, lateral or terminal (Fig. 21); (iv) stephanocysts ovoid, hyaline, two-celled with deeply staining contents and with a row of minute spines along the median septum, 12–15 x 6–7μ, sessile on short lateral protuberances of clamped hyphae (Fig. 24).

Submerged mycelium: nodose-septate hyphae as in the advancing zone, often inflated to up to 8μ diameter.

Peniophora tenuis was isolated from 18 specimens of different species of hardwood and softwood, which includes specimens both treated and untreated with preservative, on which it caused white stringy rot.

Peniophora tenuis was described in culture by Boidin (1950) who figured and named the stephanocysts which are also present in fruit-bodies of this species. Similar structures have been reported from fruit-bodies of a few other species of *Peniophora*,

closely related to *P. tenuis*, by Boidin (1950; 1958), Cunningham (1963) and Burdsall (1969). The stephanocysts described here agree closely with those of *Peniophora tenuis* as described by Boidin (1950; 1958) and Burdsall (1969). In other characters, the cultures described here also agree well with Boidin's description and, as fruit-bodies of *Peniophora tenuis* were present on some of the specimens from which these isolations were made, there can be no doubt about the identity of this species. The presence of the characteristic two-celled stephanocysts in the thin, white, felty mycelium of cultures which give a positive reaction when tested for extra-cellular oxidase enzymes, serves to distinguish this species in culture.

Stephanocysts identical to those described above, were reported by Burdsall (1969) from cultures and carpophores of *Hyphoderma tenue* and from carpophores only of *H. guttuliferum* and *H. puberum*. He also stated that the cystidia may be (i) subulate, embedded and slightly thick-walled, to long subulate, or, (ii) cylindrical and slightly thick-walled, and embedded, or, (iii) cylindrical, thin-walled and protruding beyond the hymenium. These three types may occur in the same carpophore but none react with sulfobenzaldehyde. Species which possess stephanocysts are included in the genus *Hyphoderma* Wallr. emend. Donk by Parmasto (1968).

Little is known about the ability of *Peniophora tenuis* to decay the wood in which it grows. Harmsen (1967) listed this species as one of the Corticiaceae capable of breaking down timber treated with wood preservatives. The frequent isolation of this species in the present study together with Harmsen's (1967) report indicates the importance of *Peniophora tenuis* in the earlier stage of the decay of timber.

Polyporus gilvus *Schw. ex Fr.*

Growth characters (Fig. 26).

Growth is moderately rapid to slow, the mat reaching a radius of up to 20 mm in one week and covering the plate in 3–5 weeks. Advancing hyphae even, raised to limit of growth. Mat at first thin, white, cottony, minutely striate with striae radiating from the inoculum, with irregular white, cottony patches around the inoculum. Mat darkens gradually to areas of "warm buff" "honey yellow" to "yellow ochre", the patches of mycelium around the inoculum increasing in size and number and coalescing to form irregular rounded lumps, at first "warm buff" but darkening to "buckthorn brown" and often developing minute pores. Against the sides of the dish, thin, lacquer-like areas of "buckthorn brown" to "russet" develop after five weeks.

Reverse darkens gradually, finally assuming a mottled appearance due to formation of dark-coloured areas on the mat. A faint, fragrant, mushroomy odour is given off.

On gallic and tannic acid media strong diffusion zones are formed. Little or no growth occurs on gallic acid medium but colonies up to 20 mm in diameter may form on tannic acid.

Hyphal characters.

Advancing mycelium: hyphae hyaline, branching, thin-walled, with deeply staining contents and simple septa, 2,0–4,5μ in diameter (Fig. 27).

Aerial mycelium: (i) hyphae as in the advancing zone; (ii) fibre hyphae reddish brown, branching or unbranched, thick-walled, aseptate, 2,5–4,5μ in diameter and variable in length, arising from thin-walled, septate hyphae (Fig. 28).

Fructification: (i) thin-walled, septate and reddish-brown aseptate, fibre hyphae as in the aerial mycelium; (ii) setae dark reddish-brown, subulate, conical or somewhat ventricose, 15–35 x 2,5–6,0μ (Fig. 29).

Submerged mycelium: hyphae as in the advancing zone but often somewhat distended, up to 7,0μ in diameter.

Polyporus gilvus had been described in culture before by Davidson, Campbell & Blaisdell (1938), Davidson, Campbell & Vaughn (1942), Hirt (1928), Refshauge & Proctor (1936) and Nobles (1948; 1958; 1965). The isolates of this species from South Africa agree very well with the descriptions by these authors. This species may be recognized fairly easily in culture if the small-pored fructification, bearing the setae, are formed. Cultures which lack these are however rather featureless and may be confused with a number of other species with very similar cultural characters.

Overholts (1953) reported that the basidiospores and setae formed in fructifications in culture are identical to those present in fruit-bodies found in nature.

The micromorphological characters of the structures formed in cultures of *Polyporus gilvus* agree very well with those of structures present in its carpophores as described by Fidalgo & Fidalgo (1968).

Polyporus gilvus is well known as an important white rot fungus of timber of various species of broad-leaved trees (Cartwright & Findlay, 1958). It is also a common and widely distributed fungus in South Africa and had been reported on wood of various species from the Knysna area on many occasions (Doidge, 1950). Despite its widespread distribution, it has been isolated from two specimens only during this present investigation.

Fungi isolated from the test specimens but previously described from S. Africa.

Coniophora arida (*Fries*) *Karst.*

This fungus was isolated in culture only once in the course of this study. Its cultural characters closely agreed with the author's earlier description (Van der Westhuizen, 1958). It is recognizable by the pale greyish-brownish mycelial mat which tended to soften the surface of the agar and the presence of whorls of clamps at the hyphal septa with branches often arising from the clamps. No diffusion zones were formed on gallic acid and tannic acid-malt agar although colonies of up to 45 mm and 15 mm in diameter respectively, formed on the two media in 7 days.

This fungus was associated with a brown rot of wood of *Quercus palustris.*

Kemper (1937) described the morphology of the fruit-bodies and cultural characters of *Coniophora arida.* He reported that *C. arida* caused more extensive disintegration of spruce and pine test blocks than *C. puteana.* Southam & Ehrlich (1950) found *C. arida* to be one of the fungi most frequently associated with brown rot of *Thuja plicata* poles. Under experimental conditions it was capable of causing up to 57,5% loss in dry mass after 6 months when inoculated in test blocks of western red cedar sapwood. Duncan & Lombard (1965) listed *C. arida* as one of the 10 most prevalent fungi on softwoods as well as one of the common species on hardwoods. It was also isolated frequently from the underground decayed portions of experimental pine sapwood stakes at Madison, Wis., and Corvallis, Oreg., that had been treated with various preservatives. No information on the tolerance limits of *C. arida* to various preservatives are available however.

Lenzites sepiaria (*Wulf. ex Fr.*) *Fr.*

This fungus was isolated from three specimens of wood of *Pinus* spp. on which it caused a brown rot. In cultural characters the isolates agree closely with the descriptions by Cartwright & Findlay (1958), Nobles (1948; 1965) and Van der Westhuizen (1971). The cultures also formed fructifications on blocks of *Pinus patula*, according to the method described by Matters & Da Costa (1958) which allowed their identification.

Although this fungus is one of the important species causing brown rot of timber in the United States (Duncan & Lombard, 1965) and Europe (Cartwright & Findlay, 1958) it is known in South Africa only since 1961 (Van der Westhuizen, 1971). Its comparatively frequent occurrence on these test specimens is thus in contrast to its brief history in South Africa.

Polyporus adustus *Willd. ex Fr.*

The characters of this isolate in culture agreed very well with those described by Nobles (1948; 1965), Zycha & Knopf (1966) and Van der Westhuizen (1971) for this species. Despite its association with a white rot, no diffusion zones were formed on gallic acid and tannic acid media. Colonies of up to 35 mm in diameter formed on gallic acid but no growth occurred on tannic acid. These characters together with the general texture of the mycelial mat which lack strong distinguishing micromorphological characters, serve to identify this isolate with this species.

Polyporus adustus was isolated only once and from an untreated hardwood specimen on which it was associated with a white rot. This species is not very common in South Africa, only 10 collections having been recorded (Doidge, 1950). Most of these are from the cool moist, belt of the southern Cape Province. It is one of the few isolations of a species of polypore in the present study.

Polyporus sanguineus *L. ex Fr.*

The characters of the cultures and carpophores of this species as well as the other two orange-coloured species of polypores included in the genus *Pycnoporus* Karst., were described and compared in great detail by Nobles & Frew (1962). They demonstrated by means of interfertility tests that two of these species viz., *P. sanguineus* and *P. coccineus* (Fr.) Bond & Sing. occur in South Africa and that they are very similar in cultural characters. The isolate studied here displayed the texture and colours of the mat associated with cultures of *P. sanguineus*. For this reason and because of the fact that carpophores of this species were very abundant on slashings and prunings in the immediate vicinity of the Test Plot, this isolate is assigned to this species.

This fungus was isolated from one specimen only, an untreated test stake of *Quercus mexicana* in which the orange-red mycelium was clearly evident in the white, decayed parts. This is one of the commonest and most widely distributed species of polypore in South Africa. Its carpophores were frequently seen in great numbers on prunings in the plantations around the Test Plot. Its low frequency of occurrence on these stakes is therefore rather surprising but it is not listed as a cause of decay of living oaks by Davidson, Campbell & Vaughn (1942) or of wood products by Duncan & Lombard, (1965). This indicates that the conditions prevailing in the underground portions of wooden stakes under test may not be suitable for the development of this species.

Schizophyllum commune *Fries.*

Cultures of this fungus are readily recognized by the raised, woolly to felty, white mat, the formation of a weak diffusion zone on tannic acid-malt agar but not on gallic acid-malt, and the presence in the mat of hyphae with numerous, minute lateral projections (Nobles, 1948; Van der Westhuizen, 1958). Fruit-bodies which allow the identification of the fungus, often develop on most new isolates.

S. commune is one of the commonest and most widely distributed decay fungi in South Africa (Doidge, 1950). It is listed by Duncan & Lombard (1965) as a frequent invader of wood products in the United States and of birch and aspen pulpwood in Sweden by Henningson (1967b). Cartwright & Findlay (1958) however maintain that it does not cause extensive decay despite its frequent occurrence on timber in England.

Stereum hirsutum (*Willd.*) *Pers.*

This species had been described in culture by Van der Westhuizen (1958) and the cultures isolated from the test specimens in the present study agreed very well with these descriptions. In culture this species is readily recognized by the presence of wide hyphae, 6–10μ in diameter, in the advancing mycelium with whorls of large

clamps at the septa, and the formation of a thick, felty mat which develops tough, smooth felty pads of "pinkish buff", "light buff" to "ochraceous tawny" colour. Strong diffusion zones and colonies up to 60 mm and 50 mm in diameter are formed after one week on gallic acid-malt and tannic acid-malt agar respectively.

This species, which is very common and wide spread in South Africa, was isolated from 24 test specimens, which ranks it as second in the frequency of the species encountered. Its fruit-bodies were also very numerous on decaying prunings and other woody debris in the vicinity of the Test Plot and it was one of the very few species of which fruit-bodies were present on the test stakes. It was always associated with extensive creamy white rot of both treated and untreated test specimens. Cartwright & Findlay (1958) regard this fungus as the most important cause of decay in sapwood of oak logs after felling in England. Duncan & Lombard (1965) do not list it as a cause of decay of wood products in the United States but Cowling (1957) reported it on stored hardwood lumber and pulpwood logs. Henningson (1967a, b) recorded *Stereum hirsutum* as one of the first Basidiomycetes to appear on birch and aspen pulpwood and it remained active for the entire period under observation (30 months), fruiting abundantly in autumn. He also reported it to be one of the most aggressive species in the decay of stored chips (Henningson, 1967c).

Discussion

A relatively small number of species of Basidiomycetes were recorded in this survey but some interesting facts and observations emerged nevertheless.

A surprising observation was the almost complete absence of fruit-bodies of decay fungi on the test specimens. The reasons for this are not at all clear. As the specimens were examined and collected only once per year in late autumn it is not unlikely that the prevailing conditions could have been unfavourable for fruit-body formation for many species. Removal of the specimens before they were completely decayed may also have been an important factor. But the absence of fruit-bodies made the identification of the mycelia obtained in culture almost impossible. Consequently only those species for which adequate descriptions of cultural characters exist or for which cultures could be made from fruit-bodies, could be identified reliably.

Another interesting fact is the almost complete absence here, of those species which have been used traditionally as test organisms in laboratory tests devised to evaluate the toxicity and efficacy of various wood-preservatives. Closely allied to this observation is the very low incidence of polypores, only *Lenzites sepiaria*, *Polyporus adustus*, *Polyporus gilvus* and *Polyporus sanguineus* being present. This latter species was found on one specimen only despite the fact that its conspicuous fruit-bodies were present in large numbers on prunings in the vicinity of the Field Exposure Test Plot.

The absence of polypore species is the more striking if viewed in the light of the micromorphological characters of the unidentified mycelia isolated from these specimens. The great majority of these cultures show no differentiation of hyphae into fibre hyphae or special structures. This indicates that these mycelia must belong to species of the lower Polyporaceae and Thelephoraceae, in which such structures are not present, and the Agaricaceae. The higher polypores with complex, tough fruit-bodies were thus almost entirely absent from the specimens under test.

Of the fungi identified on the test specimens, *Stereum hirsutum* proved to be one of those encountered most frequently. This is one of the commonest and most widely distributed species in South Africa (Doidge, 1950). Two other species of lower Hymenomycetes, *Odontia bicolor* and *Peniophora cinerea* were also of frequent occurrence though both were virtually unknown in South Africa before (Doidge, 1950; Talbot, 1958). Of the species which occurred most frequently however, *Paxillus*

panuoides, had been recorded in South Africa on three previous occasions only (Doidge, 1950). Their frequent presence on the specimens studied here, in comparison with their few previous records of occurrence, together with the observed general absence of fruit-bodies on the test stakes, indicate that these species must have been overlooked previously because of inconspicuous or suppressed fruit-bodies.

The species of fungi isolated and identified in this investigation agree in general with those of Henningson (1967a, b, c) who found that wood in chip piles were invaded first by species of lower Basidiomycetes with low wood-destroying activity, resulting in slow initial decay. *Stereum hirsutum* was found to be one of the early and very aggressive invaders which were followed much later by polypores. The results thus indicate that the wood specimens from Kruisfontein, examined here, had been removed while they were, in general, still in the early stages of decay, despite the fact that they have been discarded as failures. This could also account to some extent for the almost total absence of fruit-bodies on the specimens. The presence of species such as *Peniophora cinerea* which are not generally regarded as severe wood-destroyers, indicate, however, that they must play an important part in the early stages of decay of timber in contact with soil.

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Table 1.—Species of wood-rotting Basidiomycetes identified, the affected timber species, preservative treatment and number of specimens affected in the Wood-preservative Field Testing Plot at Kruisfontein.

Fungus	Timber	Treatment	No. of specimens
Coniophora arida	Quercus palustris	Natural durability	1
Lenzites saepiaria	Pinus patula	5% Celcure A	1
	Pinus palustris	Natural durability	1
	Pinus taeda	Natural durability	1
Neamatoloma fasciculare	Berlinia sp.	Natural durability	1
	Eucalyptus capitulata	Natural durability	1
	Eucalyptus pillularis	Natural durability	1
	Gymnosporia acuminata	Natural durability	1
	Heywoodia lucens	Natural durability	1
Odontia bicolor	Eucalyptus saligna	5% Celcure	1
	Eucalyptus saligna	Lignolite	1
	Eucalyptus saligna	SATMAR creosote substitute	1
	Pinus patula	5% Magnesium silicofluoride	1
	Adina macrocephala	Natural durability	1
	Afrormosia angolensis	Natural durability	1
	Cordia caffra	Natural durability	2
	Eucalyptus botryoides	Natural durability	1
	Eucalyptus corymbosa	Natural durability	1
	Eucalyptus globulus	Natural durability	1
	Eucalyptus propingua	Natural durability	1
	Mellitia caffra	Natural durability	1
	Syncarpia laurifolia	Natural durability	2

TABLE 1.—Species of wood-rotting Basidiomycetes identified, the affected timber species, preservative treatment and number of specimens affected in the Wood-preservative Field Testing Plot at Kruisfontein (*Continued*).

Fungus	Timber	Treatment	No. of specimens
Paxillus panuoides..........	Pinus patula...........	5% Celcure A..........	2
	Pinus patula...........	Copper - 3 - phenylsalicylate	1
	Pinus patula...........	0,257% Dieldrin........	1
	Pinus patula...........	5% Monochloronahpthalene	3
	Pinus patula...........	Rosin amine "D" acetate	1
	Pinus patula...........	Rosin amine "D" pentachlorophenate	1
	Pinus patula...........	Sodium orthophenylphenate	1
	Pinus patula...........	1% Triolith + 0,68% Copper sulphate	1
	Pinus patula...........	Untreated control.......	14
	Pinus oocarpa..........	Natural durability.......	1
Peniophora aspera..........	Eucalyptus saligna......	SATMAR creosote substitute B	1
	Pinus patula...........	Sodium orthophenyl phenate	1
	Pinus patula...........	Untreated control.......	2
	Curtisia dentata........	Natural durability.......	1
	Pinus pinaster..........	Natural durability.......	1
	Pterocelastrus tricuspidata	Natural durability.......	1
Peniophora cinerea..........	Eucalyptus saligna......	Albolineum............	1
	Eucalyptus saligna......	0,257% Dieldrin........	2
	Pinus patula...........	Sodium orthophenyl phenate	2
	Pinus patula...........	Untreated control.......	1
	Ekebergia capensis......	Natural durability.......	1
	Fraxinus americana.....	Natural durability.......	3
	Ptaeroxylon obliquum...	Natural durability.......	1
	Quercus mexicana.......	Natural durability.......	2
Peniophora tenuis...........	Eucalyptus saligna......	Sodium orthophenylphenate	2
	Eucalyptus saligna......	Copper naphthenate, 5%	1
	Eucalyptus saligna......	Dieldrin...............	1
	Eucalyptus saligna......	Lignolite...............	1
	Eucalyptus saligna......	10% Metanate zinc naphthanate	1
	Eucalyptus saligna......	Rosin Amine "D" acetate	1
	Eucalyptus saligna......	5% Wykamol..........	2
	Eucalyptus saligna......	Untreated control.......	1
	Pinus patula...........	Magnesium silicofluoride	2
	Pinus patula...........	Orthophenyl phenol.....	2
	Pinus patula...........	SATMAR creosote......	1
	Pinus patula...........	Tanalith "U"...........	1
	Pinus luchuensis........	Natural durability.......	1
	Pinus michoacana.......	Natural durability.......	1
Polyporus adustus...........	Ilex mitis.............	Natural durability.......	1
Polyporus gilvus............	Albizzia gummifera.....	Natural durability.......	1
	Eucalyptus sideroxylon..	Natural durability.......	1
Polyporus sanguineus........	Quercus mexicana.......	Natural durability.......	1
Schizophyllum commune.....	Fraxinus pennsylvatica..	Natural durability.......	1
	Populus serotina........	Natural durability.......	1
	Vepris lanceolata.......	Natural durability.......	1
	Zyzygium cordatum.....	Natural durability.......	1

TABLE 1.—Species of wood-rotting Basidiomycetes identified, the affected timber species, preservative treatment and number of specimens affected in the Wood-preservative Field Testing Plot at Kruisfontein (*Continued*).

Fungus	Timber	Treatment	No. of specimens
Stereum hirsutum...........	Eucalyptus saligna......	5% Celcure "A"........	2
	Eucalyptus saligna......	5% Copper naphthanate + 1% Sodium dichromate	2
	Apodytes dimidiata.....	Natural durability.......	1
	Betula sp..............	Natural durability.......	2
	Eucalyptus paniculata...	Natural durability.......	1
	Eucalyptus pedunculata..	Natural durability.......	1
	Eucalyptus saligna......	Natural durability.......	1
	Fraxinus americana.....	Natural durability.......	3
	Gymnosporia acuminata.	Natural durability.......	2
	Kempas...............	Natural durability.......	1
	Nuxia floribunda.......	Natural durability.......	4
	Quercus mexicana.......	Natural durability.......	2
	Rapanea melanophloeos.	Natural durability.......	2

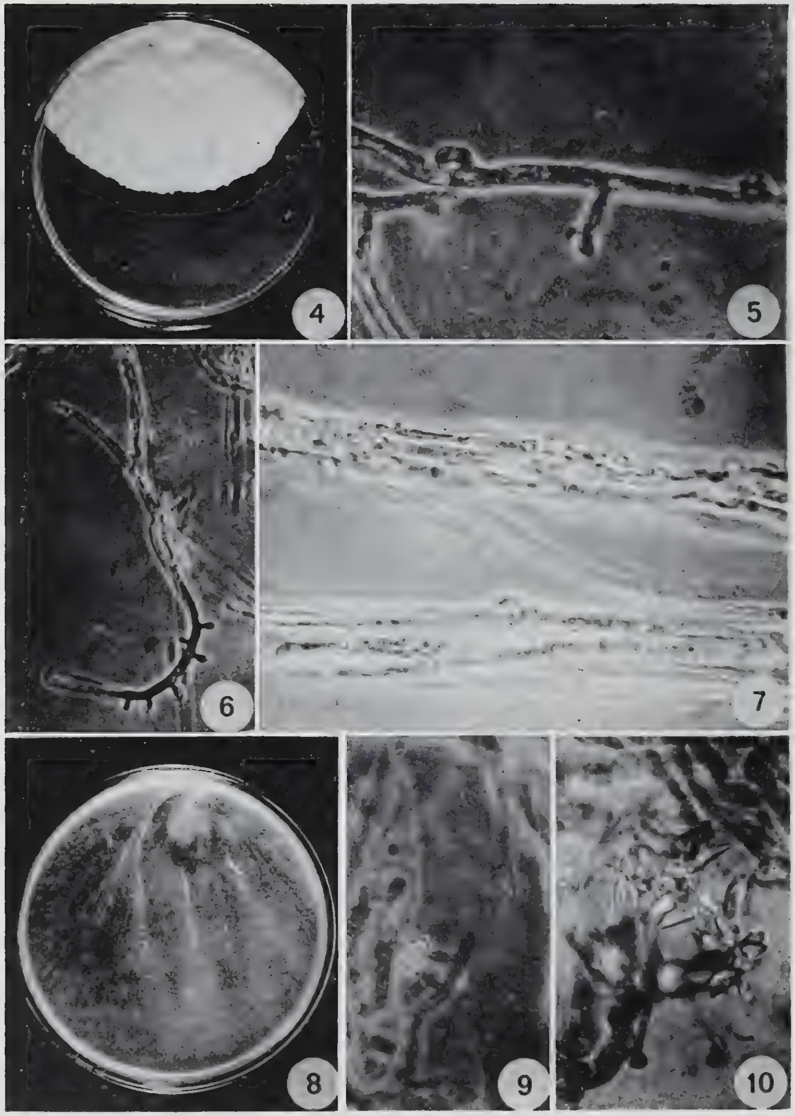
TABLE 2.—Unidentified mycelia of Basidiomycetes together with the species of timber and preservative treatment from which they were isolated, arranged according to their main cultural characters.

Cultural characters	Isolate no.	Timber species	Preservative treatment
1. Extra-cellular oxidase reaction negative;			
1.1 Thin-walled hyphae nodose-septate;			
1.1.1 Hypha undifferentiated, hyaline:	106	Eucalyptus saligna......	Creosote.
	198	Albizzia gummifera.....	Natural durability.
	207	Zyzygium cordatum.....	Natural durability.
	220	Pinus patula............	5% Zinc silicofluoride.
	270	Eucalyptus saligna......	Permatox W.R. + Varnolene.
	271	Eucalyptus saligna......	Coppernaphthanate + Varnolene.
	292	Pinus patula............	Ortho-phenylphenol.
	295	Vepris lanceolata.......	Natural durability.
	297	Vepris lanceolata.......	Natural durability.
	393	Pinus patula............	Natural durability.
1.1.2 Clamped hyphae with irregularly thickened walls also present:			
	187	Eucalyptus saligna......	25% Permatox W.R. + 75% Varnolene.
	285	Curtisia dentata.........	Natural durability.
	289	Pinus patula............	Sodium ortho-phenylphenate.
	303	Populus serotina........	Natural durability.
	304	Pinus patula............	Relysol.
	305	Pinus patula............	Untreated control.
	403	Pinus patula............	Untreated control.
1.1.3 Swellings on clamped hyphae:			
	192	Pinus patula............	2% Sodium orthophenylphenate.

TABLE 2.—Unidentified mycelia of Basidiomycetes together with the species of timber and preservative treatment from which they were isolated, arranged according to their main cultural characters (*Continued*).

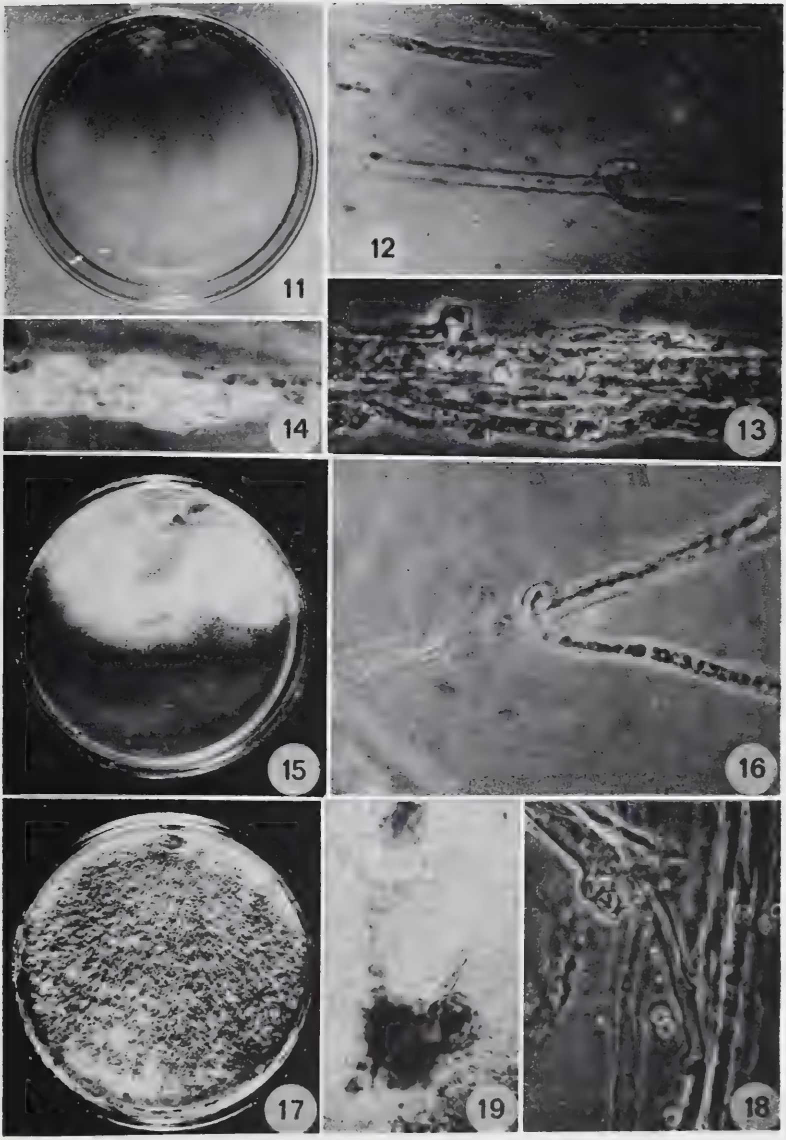
Cultural characters	Isolate no.	Timber species	Preservative treatment
	283	Eucalyptus saligna......	Albawax in kerosene.
	287	Eucalyptus saligna......	Copper-3-phenylsalicylate.
1.1.4 Differentiated thick-walled fibre hyphae also present:			
	223	Pinus patula...........	Untreated control.
1.2 Thin-walled hyphae simple-septate, undifferentiated:			
	188	Eucalyptus saligna......	10% Coppernaphthanate in diesel oil.
	203	Pinus patula...........	Untreated control.
1.2.1 Advancing hyphae simple septate, older hyphae nodose-septate:			
	229	Quercus mexicana.......	Natural durability.
2. Extra-cellular oxidase reaction positive;			
2.1 Thin-walled hyphae nodose-septate;			
2.1.1 Hyphae undifferentiated, hyaline:			
	100	Eucalyptus saligna......	2% Copper sulphate + 1% Sodium dichromate.
	103	Apodytes dimidiata.....	Natural durability.
	104	Eucalyptus saligna......	Cresoleum.
	105	Eucalyptus obliqua......	Natural durability.
	106	Eucalyptus saligna......	Creosote.
	190	Eucalyptus saligna......	Albolinium.
	202	Pinus patula...........	Untreated control.
	205	Pinus patula...........	Untreated control.
	206	Pinus patula...........	Untreated control.
	272	Eucalyptus saligna......	Coppernaphthanate in diesel oil.
	302	Populus serotina........	Natural durability.
	396	Eucalyptus gomphocephala	Natural durability.
	399	Gymnosporia acuminata.	Natural durability.
	402	Pinus patula...........	3,75% Tim-Bor.
	405	Pinus patula...........	Watco Timber guard.
	408	Pinus oocarpa..........	Natural durability.
	410	Gymnosporia acuminata.	Natural durability.
2.1.2 Differentiated fibre hyphae also present:			
	145	Fraxinus americana.....	Natural durability.
	150	Harpephyllum caffrum...	Natural durability.
	235	Rapanea melanophloeos.	Natural durability.
2.2 Thin-walled hyphae simple septate;			
2.2.1 Hyphae undifferentiated:			
	109	Nuxia floribunda.......	Natural durability.
	234	Fraxinus americana.....	Natural durability.
	288	Eucalyptus saligna......	Sodium orthophenyl phenate.
	412	Pinus patula...........	Untreated control.
	413	Heywoodia lucens.......	Natural durability.

FIGS. 1–3.—General views. Fig. 1, the wood-preservative field exposure test plot. Fig. 2. Test specimen with fruit-body of **Peniophora** sp. at groundlevel. Fig. 3. Fruit-bodies of **Stereum hirsutum** on billet under test for natural durability.



FIGS. 4–7.—**Naematoloma fasciculare.** Fig. 4, culture at two weeks. Fig. 5, nodose-septate hyphae from advancing zone, x 1000 phase contrast. Fig. 6, dendrophysis from aerial mycelium, x 500 phase contrast. Fig. 7, strands of aerial hyphae, x 1000 phase contrast.

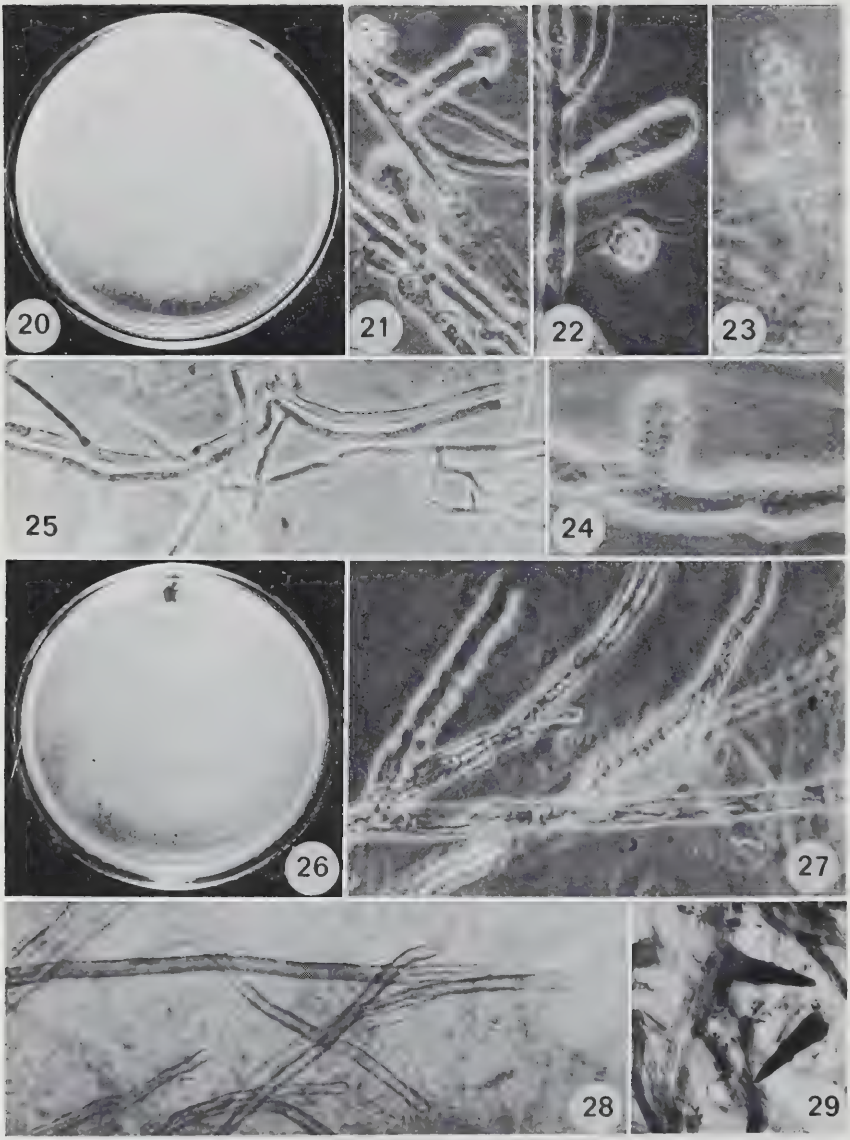
FIGS. 8–10.—**Odontia bicolor.** Fig. 8, culture at four weeks. Fig. 9, nodose-septate hyphae and capitate cystidia, x 1000 phase contrast. Fig. 10, capitate cystidia with encrusting crystals, x 1000 in lactophenol with Cotton Blue.



FIGS. 11–14.—**Paxillus panuoides.** Fig. 11, culture at 4 weeks. Fig. 12, nodose-septate advancing hyphae, x 1000. Fig. 13, hyphal strand from aerial mycelium, x 1000 phase contrast. Fig. 14, crystalline incrustations on hyphae, x 1000 phase contrast.

FIGS. 15–16.—**Peniophora aspera.** Fig. 15, culture at 4 weeks. Fig. 16, nodose-septate hypha from advancing zone, x 1000 phase contrast.

FIGS. 17–19.—**Peniophora cinerea.** Fig. 17, culture at 4 weeks, Fig. 18, nodose-septate hyphae from advancing zone, x 1000 phase contrast. Fig. 19. brown hyphae with drops of brown, resin-like material, x 500.



FIGS. 20–25. —**Peniophora tenuis.** Fig. 20, culture at 4 weeks. Fig. 21, capitate cystidia, x 1000 phase contrast. Fig. 22 and Fig. 23, cystidia with crystalline incrustations, x 1000 phase contrast. Fig. 24, stephanocyst, x 1000 phase contrast. Fig. 25, nodose-septate hyphae from advancing zone, x 500 phase contrast.

FIGS. 26–29. —**Polyporus gilvus.** Fig. 26, culture at 4 weeks Fig. 27, simple-septate hyphae from advancing zone, x 1000 phase contrast. Fig. 28, brown, aseptate fibre hyphae, x 500. Fig. 29, setae, x 500.

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A New Species of Encephalartos from Swaziland

by

R. A. Dyer*

Abstract

Encephalartos **heenanii** R. A. Dyer is described for the first time. It is indigenous in Swaziland and is nearest related to *E. paucidentatus* Stapf & Burtt Davy.

The Cycads of Southern Africa seem to have endless surprises in store for those whose investigations penetrate deeper into relatively unexplored territory. On this occasion, in addition to the record of a previously undescribed species, it is possible to give for the first time descriptions and illustrations of fresh male and female cones of *Encephalartos paucidentatus* Stapf & Burtt Davy from Swaziland. This is appropriate because *E. paucidentatus* is the nearest related species to *E. heenanii.* The records are made possible by the field work of Mr Denis Heenan and his son David.

Encephalartos heenanii *R. A. Dyer*, sp. nov., *E. paucidentato* Stapf & Burtt Davy affinis, sed planta e basi plus ramosa, truncis minoribus, foliis brevioribus, foliolis non recurvis, strobilis dense brunneo-hirtolanatis, microsporophyllarum bulla crassiore et breviore differt.

Planta e basi ramosa; trunci erecti vel ascendentes vel aetate provecta decumbentes, ad 2,25 m alti, 25–35 cm diam.; cataphylla acuminato-lanceolata, brunneolanosa. *Folia* initio dense hirto-lanata glabrescentia, oblongo-lanceolata, 100–130 cm longa, 15–20 cm lata; petiolus circa 20 cm longus, pulvino dense hirto-lanato. *Foliola* media oblongo-lanceolata, pungentia, 12–15 cm longa, plus minusve 1,5 cm lata, marginibus edentatis, infra manifeste 20–30-nervata. *Strobili* pilis brunneis hirtolanatis. *Strobilus masculinus* solitarius, subcylindricus, compactus, 25–30 cm longus, 15–17 cm diam., pedunculo 8–9 cm longo, 2,5–3,5 diam.; microsphorophylla mediana late cuneata, patentia, 6,5–7 cm longa, 5,5–6 cm lata; bulla subcylindrica, 1,3–1,5 cm longa, circa 2,5 cm crassa, verrucosa, copiose brunneo-lanata; vulticulus terminalis circa 1,75 cm latus et altus. *Strobilus femineus* solitarius late ovatus, 23–30 cm longus, 17–18 cm latus, pedunculo 5–6 cm longo, 4 cm diam. obconico, tomentoso; megasphorophylla mediana 6–6,5 cm longa, 5–5,5 cm lata; bulla subcylindrica, circa 2,5 cm longa et 2,5 cm crassa, verrucosa, dense brunneo-lanata; vulticulus terminalis 2–2,5 cm latus, 1,7–2 cm altus.

Type: Swaziland.—Piggs Peak, on krantzes, Sept. 1969, *D. Heenan* in PRE 30904 (PRE, holo.).

Plants branched form the base; trunks erect or ascending, sometimes becoming procumbent with age, up to about 2,25 m tall, 25–35 cm diam.; bracteate leaves linear-lanceolate, very densely woolly with long brown hairs, tips recurving and becoming dry and brittle. *Leaves* with long brownish woolly hairs when young, gradually glabrescent except pulvinus, oblong-lanceolate in outline, 100–130 cm long, 15–20 cm broad, slightly contracted to apex and base; rhachis somewhat twisted; petiole about 20 cm long; leaflets (pinnae) slightly spaced towards base, denser above, sometimes slightly overlapping; upper ones slightly curved towards apex; basal ones not reduced to prickles but 1 or 2 sometimes lobed and somewhat prickle-like;

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PLATE 1.—**Encephalartos heenanii;** top, habit with David Heenan; bottom left, male cone; right, female cone.

margin entire, except very rarely with 1 or 2 prickles in juvenile forms; median leaflets fairly widely spreading or reflexed from the rhachis, oblong-lanceolate, 12–15 cm long, about 1,5 cm broad, becoming rigid, undersurface drying with 20–30 prominent nerves. *Cones* single, sometimes terminal, usually lateral to the terminal leaf-whorl, densely shaggy brown woolly, rarely glabrescent, yellowish, male and female alike in general shape, but male much lighter in mass per unit volume than female. *Male cones* pedunculate; peduncles 8–9 cm long, 2,5–3,5 cm diam. below cone, tapered to base, velvety woolly, without stipules except subtending ones; cones subcylindric, 27–30 cm long, 15–17 cm diam., broadest slightly below the middle and narrowed slightly to apex and broadly rounded base, shaggy woolly with brown hair about 1 cm long, with only the uppermost weathered scale-faces slightly exposed; scale-faces smallest towards apex; median scales spreading more or less horizontally, 6,5–7 cm long, 5,5–6 cm broad at the shoulder, cuneately narrowed to base, shortly stalked; stalk about 1 cm long; limb glabrous, 4–6 mm thick, with sterile margin 3–4 mm wide; bulla 1,3–1,5 cm long, subcylindric, about 2,5 cm thick vertically, abruptly expanded into lateral wings, densely woolly, verrucose; upper facet humped and apparently more or less rounded, 1 cm higher than sporangial spine; lower facet rounded; terminal facet not clearly defined, flattish, verrucose, about 1,75 cm broad and 1,5 wide vertically. *Female cones* pedunculate; peduncles obconic, 5–6 cm long, 4 cm diam. at top, velvety woolly; cones broadly ovate, 23–30 cm long, 17–18 cm broad, shaggy woolly as with male cones; median scales 6–6,5 cm long, 5–5,5 cm broad at the shoulders, 2,5–3 cm thick vertically, with incurved toothed lateral lobes 5–10 mm long; bulla 2,5 cm long, about 2,5 cm thick vertically, abruptly expanded into lateral wings, shaggy woolly, verrucose; upper facet humped with 1 or 2 ridges; lower facet rounded; terminal facet 2–2,5 cm broad, 1,7–2,0 cm wide vertically; seeds angled by compression 3,75–4 cm long with fleshy beak (immature).

SWAZILAND.—2531 CC (Komatipoort): Piggs Peak district, on krantzes, Sept. 1969, *D. Heenan* in PRE 30904; Nov. 1969, *D. Heenan* in PRE 30953; June, 1971, *D. Heenan* in PRE 31825a (male cone); 31825b (female cone).

The first notification of this species came from Mr. Denis Heenan in August, 1969. At this time no fresh cones were available and the remains of old ones were severely damaged by insects and were largely disintegrated. Mr. Heenan had located *E. paucidentatus* Stapf & Burtt Davy in quantity a kilometer and a half away and *E. laevifoluis* Stapf & Burtt Davy slightly further. It seemed prudent not to ignore the possibility that *E. heenanii* had originated by hybridisation between these two species known to occur in the same neighbourhood. No supporting evidence for this idea was found, however. But the more knowledge gathered of *E. heenanii* the more definite it became that it should have separate specific status. The development and collection of fresh cones in 1971 was the final proof required and was a fitting reward for Mr. Heenan's patient field work with the able assistance of his son David.

The length and density of the shaggy brown hair on emerging leaves is phenomenal (Fig. 1) but gradually most of it is shed before the leaves reach maturity. A most unusual feature of the loosely brown woolly cones is that the male and female are similar in size and shape. They are not readily distinguishable on sight because of the similarity of the scale-faces which are almost invariably covered with copious brown shaggy hair. On handling the cones it is at once evident that the male is far lighter than the female per unit volume: the male has considerable air space between the pollen-bearing surfaces and shrinks appreciably on drying, whereas the female cones are nearly solid and shrink far less. The observation by Mr. Heenan of one practically glabrous cone on a plant with one normal shaggy cone was a distinct surprise and at this stage no explanation can be presented. This type of variation has not been observed in any other species with normally woolly cones.

PLATE 2.—**Encephalartos heenanii;** top, ad- and abaxial views of male cone-scales; bottom, ad- and abaxial views of female cone-scales with young seeds.

PLATE 3.—**Encephalartos heenanii,** emerging young leaves.

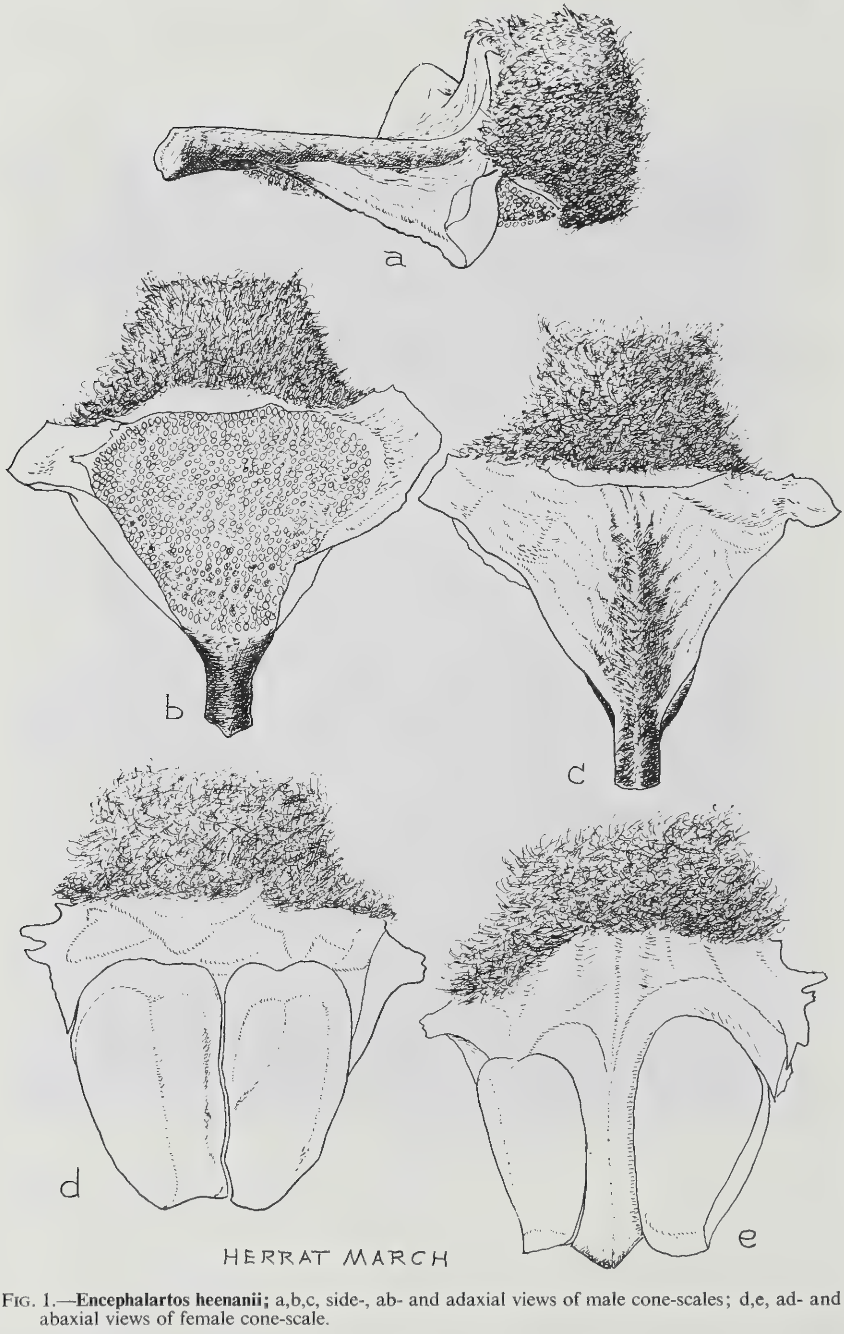

FIG. 1.—**Encephalartos heenanii;** a,b,c, side-, ab- and adaxial views of male cone-scales; d,e, ad- and abaxial views of female cone-scale.

Encephalartos paucidentatus *Stapf & Burtt Davy*. As in other species of the genus, there is appreciable variation between individual specimens over the full range of distribution. Unless one is able to make regular field observations over a number of seasons there is little chance of noting all the possible variations. Recordings are thus done piecemeal.

The number of cones produced by a trunk of *E. paucidentatus* was thought to be 1–3. In the mountain kloofs near Piggs Peak, where the species is sometimes common, David Heenan found female trunks with up to 3 large cones and male trunks with up to 5 cones. Unlike *E. heenanii*, where the male and female cones are almost indistinguishable, the difference in male and female cones of *E. paucidentatus* is very marked. For one thing the male cones are far more slender than the female cones and for another the median male cone-scales have a relatively long narrow beak to the bulla with a small terminal facet.

Since no description has been published of fresh male and female cones of *E. paucidentatus*, this opportunity is taken of recording them with illustrations (see Plate 4).

Cones yellowish, sometimes slightly woolly when young, irregularly papillate-pubescent with reddish-brown and colourless hairs; hair falling with age but bulla-face not becoming altogether glabrous.

Male cones 1–5 together at the apex of stems, subcylindric, slightly narrowed to base and apex, 40–50 (60) cm long, 12–15 cm diam., with cylindric peduncle about 10 cm long and subtended by slender acuminate woolly bracts; median scales narrowly oblong, up to 5,5 cm long, 2,5 cm broad, nearly flat on upper surface and with microsporangia extending nearly to the lateral margins and base; bulla decurved with sharp lateral angles, 1,5–2 cm long, 1,2–1,5 cm thick vertically; upper facet with median ridge; lower facet more or less continuous with sporangial surface; terminal facet 1–1,2 cm broad and slightly less vertically, with minutely irregular margin; the width of the terminal facets from base to apex of cone fairly constant while the vertical measurement decreases to about half.

Female cones 1–3 together at apex of stems, oblong-oval, 35–50 cm long, 20–22 cm in their greatest diam., with short stout obconic peduncle and subtended by slender acuminate woolly bracts; median scales 6,5 cm long; bulla verrucose, about 3 cm long, projecting 1,5–2 cm, 4–4,5 cm broad, 2,7–2,8 cm thick vertically, with lateral ridges extending into incurved lateral lobes about 1 cm long; upper facet rounded, indistinctly ridged; lower facet slightly convex; terminal facet concave, verrucose, 2–3 cm broad, 1–2 cm wide vertically; terminal facets becoming gradually smaller towards the apex of the cone.

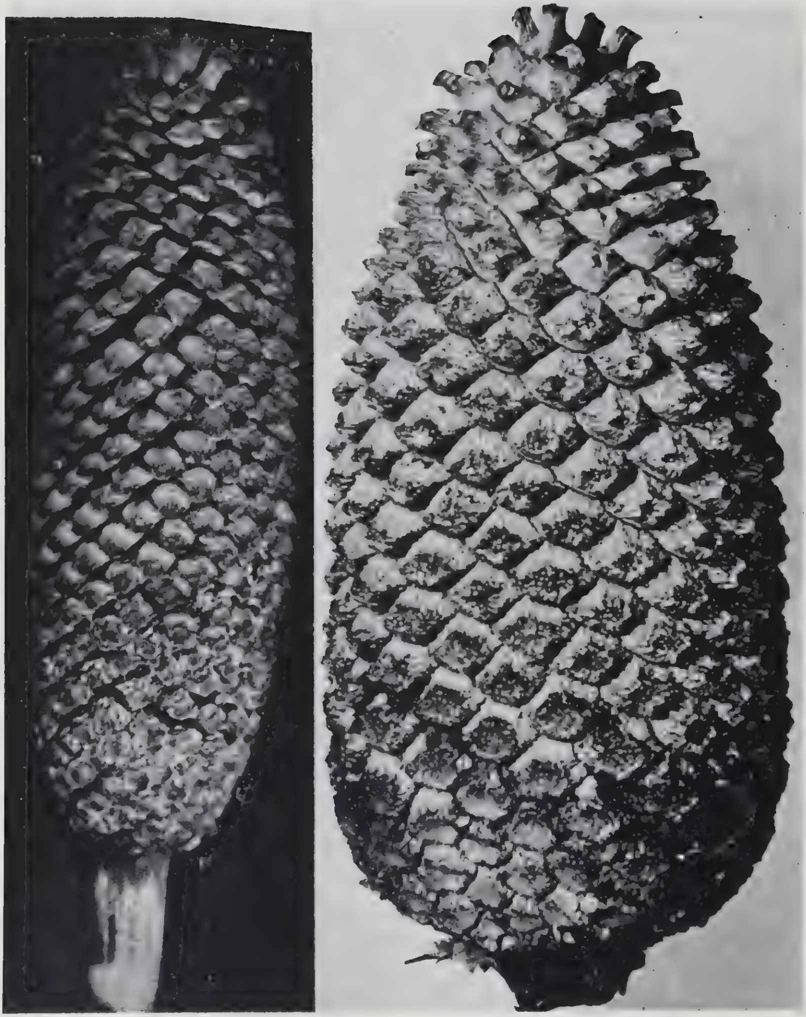

PLATE 4.—**Encephalartos paucidentatus**; left, male cone; right, female cone.

Bothalia, 10, 4: 547–553

Notes on Acacia Species in Southern Africa: II

by

J. H. Ross*

ABSTRACT

Some information concerning miscellaneous *Acacia* species is presented. The typification of *A. galpinii* Burtt Davy is discussed, attention is drawn to an unusual specimen of *A. giraffae* Willd. and to the seedling development of *A. haematoxylon* Willd., and the identity of *A. inermis* Marl. is discussed. The continued confusion over the identity of *A. heteracantha* Burch. is considered and the misapplication of this name in the literature is traced. The location of type specimens of *A. spirocarpoides* Engl. and of *A. maras* Engl. is recorded.

ACACIA GALPINII Burtt Davy

Burtt Davy in Kew Bull. 1922: 326 (1922) based his description of *A. galpinii* on *Galpin* 483M which was collected in the Waterberg district of the Transvaal on 19th Sept. 1920. The date of collection of the type specimen is important as Galpin returned to the type locality, or probably to the original tree, in later years and collected further specimens which he also numbered 483 M. In addition to the specimens of 483 M collected on 19th Sept. 1920 specimens of 483 M collected on the following dates have been examined: 21st Sept. 1923 (PRE); 22nd March 1924 (PRE); 25th Sept. 1927 (BOL, SRGH); Dec. 1927 (SRGH); 10th April 1928 (BM, BOL, PRE, SRGH).

Galpin's continued use of the number 483M over a period of years has led to confusion in several herbaria. Only those specimens of 483 M collected on 19th Sept. 1920 can be regarded as forming part of the type collection. All of the specimens of 483 M collected subsequently were collected after *A. galpinii* was described and cannot therefore be regarded as type specimens even although they were probably collected from the type-tree.

In addition, it appears that Galpin, in at least one instance, gave two sets of numbers to some of his specimens for specimens in BM, BOL, PRE and SRGH collected on 10th April 1928 are numbered 483 M while specimens in K and NH collected on the same day are numbered 14009.

Acacia galpinii *Burtt Davy* in Kew Bull. 1922: 326 (1922). Type: Transvaal, Waterberg district, banks of Bad-Zyn-loop River, Mosdene Estate, Naboomspruit, 19th Sept. 1920, *Galpin* 483 M (K, holo., BM, GRA, PRE, iso.).

Syn. *A. dulcis* sensu Henkel in Woody Plants of Natal and Zululand: 233 (1934).

ACACIA GIRAFFAE Willd.

The greyish velvety pods of *A. giraffae*, although varying somewhat in size and in shape, are very characteristic. During the examination of material of *A. giraffae*, attention was drawn to a specimen with atypical pods, namely, *Strey* 2292 from the Rehoboth district of South West Africa. The pods, although not quite mature, are very distinctly coiled and are only up to 2,2 cm wide which is much smaller than those of typical *A. giraffae* (see Fig. 1). However, the pods are not in any way similar to those found on plants regarded as hybrids between *A. giraffae* and *A. haematoxylon* Willd. (Ross in Bothalia 10: 359–362, 1971). A photograph of the plant from which *Strey* 2292 was collected reveals that all of the pods on the tree were of a similar shape and size. Apart from the pods *Strey* 2292 is otherwise indistinguishable from specimens of typical *A. giraffae*. The pods of *A. erioloba* E. Mey.,

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which is a synonym of *A. giraffae*, were described as "semilunate". These are probably similar to those of typical *A. giraffae* but unfortunately I have not succeeded in tracing the type specimen of *A. erioloba*.

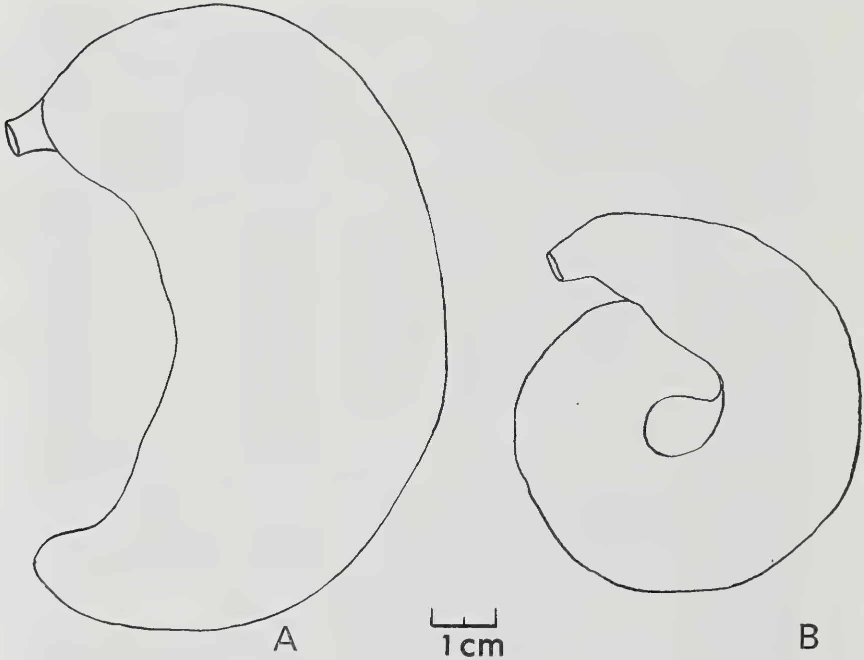

FIG. 1.—A, the outline of a "typical" pod of *Acacia giraffae* (*Meeuse* 10143); B, the outline of a pod from *Strey* 2292.

ACACIA HAEMATOXYLON Willd.

A. haematoxylon is easily distinguished from all other *Acacia* species in southern Africa by its fine greyish foliage, the leaflets being very tightly compressed laterally so that the leaves appear superficially simply pinnate. Some years ago seeds collected in the Kalahari were germinated in Durban and the seedlings were watched. The leaves produced during the first three years were distinctly bipinnate and quite unlike those found on more mature plants. The leaflets on these juvenile leaves were quite discrete and were up to 3 mm long and 1,3 mm wide in contrast to the small laterally compressed leaflets up to 0,8 mm long and 0,4 mm wide found on adult leaves. The single surviving plant of *A. haematoxylon* in Durban has grown very slowly and is only 0,6 m high after five years.

ACACIA INERMIS Marl.

Marloth based the name *A. inermis* on his specimen number 1317 which he collected near Otjimbingwe in Hereroland in May 1886. *A. inermis* is a *nomen nudum* for although the name appears on the specimen, *Marloth* 1317, Marloth never validly published this name. This is explained in a paper read by Marloth on 26th Oct. 1887

and subsequently published in Trans. S. Afr. Phil. Soc. 5: 267–274 (1889). Marloth (l.c.: 269) wrote: "... I have to mention another new species from Damaraland, which I had named *inermis*, on account of its having no spines or prickles whatever, but the name of which has been changed by Professor Engler to that of *A. marlothii*." Engler's description of *A. marlothii* appeared in Bot. Jahrb. 10: 19 (1888). A further reference to *A. inermis* may be found in a paper by Wordsworth, Hutchinson, F. Bolus and L. Bolus in Ann. Bol. Herb. 3: 21 (1920). Examination of *Marloth* 1317, the type of *A. marlothii*, revealed that the species is an *Albizia* and that it must be regarded as a synonym of *Albizia anthelmintica* (A. Rich.) Brongn.

ACACIA TORTILIS (Forsk.) Hayne subsp. HETERACANTHA (Burch.) Brenan

Brenan in Kew Bull. 1957: 88 (1957) regarded *A. heteracantha* Burch. and *A. litakunensis* Burch. as synonymous with each other and referred both to *A. tortilis* subsp. *heteracantha*. However, the status and identity of *A. heteracantha* and *A. litakunensis* remained a matter of controversy. In response to a request Brenan re-investigated the matter and his findings were published in Kew Bull. 13: 409–411 (1959). Despite Brenan's full and convincing explanation some workers remain unconvinced and maintain that the use of the epithet "*heteracantha*" is unfortunate in view of the past confusion and uncertainty over its identity. Evidence is now led in support of Brenan's conclusions and the confusion over the name *A. heteracantha*, and the subsequent misapplication of this name, will be traced in the literature.

The confusion over the identity of *A. heteracantha* rests on Burchell's description of the pods as "Legumen lineare" in his type description in his Travels in the interior of Southern Africa I: 389 (1822). The type specimen of *A. heteracantha* (*Burchell* 1710 in K) is a sterile twig (see Plate I) and was collected at Springslangfontein between Griquatown and the Orange River. This type specimen has very small leaves with rhachides up to 8 mm long, rhachillae up to 8 mm long, leaflets 1–2 mm long and the straight stipular spines are very slender being only 1,5 mm in diameter at the base. The type specimen agrees well with Burchell's description of *A. heteracantha* except for the words "legumen lineare".

As *A. luederitzii* Engl. and *A. hebeclada* DC. (syn. *A. stolonifera* Burch.) also grow in the northern Cape Province, it is fortunate that this sterile type specimen of *A. heteracantha* can be positively identified. Like *A. heteracantha*, *A. luederitzii* and, less frequently, *A. hebeclada* often have a mixture of short recurved and long straight stipular spines and sterile specimens of *A. luederitzii* and *A. hebeclada* sometimes superficially resemble those of *A. heteracantha*. However, *A. luederitzii* has linear legumes. Burchell's description of *A. heteracantha*, particularly when the comment "legumen lineare" is considered, actually fits plants in the *A. luederitzii* complex more accurately. Consequently it is quite understandable why some workers, especially those who never saw the type specimen of *A. heteracantha*, applied the name *A. heteracantha* to plants in the *A. luederitzii* complex.

Sterile material of *A. heteracantha* can be distinguished from material of *A. luederitzii* and *A. hebeclada* without much difficulty. Indeed, it is usually much simpler to distinguish sterile specimens of *A. heteracantha* from *A. luederitzii* or from *A. hebeclada* than it is to distinguish sterile specimens of *A. luederitzii* and *A. hebeclada* from one another. Material of *A. heteracantha* from the northern Cape differs from *A. luederitzii* and *A. hebeclada* (corresponding dimensions of these two species respectively are given in brackets after those of *A. heteracantha*) from the same locality in having smaller leaves with rhachides 0,2–1,8 (1–3,4; 1,5–4,2) cm long, rhachillae 0,3–1,4 (0,8–2,8; 0,8–2,8) cm long and leaflets 1–2,5 × 0,6–1 (2–4,5 × 0,5–1,5; 2,2–5,3 × 0,9–1,5) mm. The short recurved and long straight spines of *A. heteracantha* are more slender than those of *A. luederitzii* and *A. hebeclada*, the straight spines of the two latter species being usually 2–3 mm in diameter basally.

PLATE 1.—*Burchell* 1710, the type specimen of **Acacia heteracantha** (x 1). (By permission of the Director, Royal Botanic Gardens, Kew).

These characters when considered collectively enable *A. heteracantha* to be distinguished. There is a difference in the growth form of the three species and Burchell particularly commented on his *A. heteracantha* having a "thick clear simple stem (frequently crooked) and may be distinguished by its growth form half a mile off".

Brenan (1959) mentions that there is evidence in Burchell's MS "Catalogus Geographicus Plantarum Africae Australis Extratropicae" at Kew that the comment about the pod of *A. heteracantha* was not written at the same time as Burchell described the type-tree. Brenan states: "There is in fact nothing in the catalogus except the added phrase (Legumen Acaciae capensis) to indicate that the type-tree was in fruit, and it seems probable that the phrases "Legumen Acaciae capensis" in the catalogus and "Legumen lineare" in the Travels were not derived from the type-tree of *A. heteracantha*".

Burchell collected his type specimen of *A. heteracantha* on 25th October 1811 and this date of collection is very important. In Southern Africa *A. tortilis* usually starts flowering in November or in December and pods are found from January onwards until August at the latest. Examination of all available specimens from the northern Cape and from Botswana has not revealed a single specimen with pods that was collected as late as October and only one specimen with pods collected in August. It seems, therefore, extremely unlikely that Burchell would have found pods on the tree or on the ground (the pods are relished by game and are usually eaten soon after falling) when he collected his type specimen as there is no record of a fruiting specimen collected as late as October. This supports Brenan's contention that the description of the pods was not written at the same time as Burchell described the type-tree.

Dr. L. E. Codd has suggested that after Burchell collected the sterile type specimen of *A. heteracantha* on 25th October 1811 he may have later encountered a plant exhibiting a mixture of short recurved spines and long straight spines with straight pods (a member of the *A. luederitzii* complex) and that Burchell may have mistaken this plant for his *A. heteracantha*. This could explain why Burchell added the comment "legumen lineare" to his type description. However, if this did happen Burchell apparently never collected a specimen for there is no fruiting specimen of a member of the *A. luederitzii* complex in his collection now.

There is evidence that Burchell was uncertain of the identity of the taxon he named *A. heteracantha* because he later collected sterile specimens, 2397 and 2402, of another species under the name *A. heteracantha*. However neither of these specimens was cited with the type description of *A. heteracantha*. Unfortunately *Burchell* 2397 and 2402 cannot be identified with absolute certainty; they are either *A. hebeclada* or *A. luederitzii*. Burtt Davy in his Fl. Transv. 2: 340 (1932) cites these specimens under *A. hebeclada* but I feel that they resemble *A. luederitzii* more closely. It may be argued that, if the specimens are *A. hebeclada*, Burchell should have recognized them as such for *A. hebeclada* was based on his specimen number 2267 and his own *A. stolonifera* (a synonym of *A. hebeclada*) on *Burchell* 2138. *Burchell* 2397 was collected from a shrub 1,2 m high and 2402 from a shrub 1,5 m high.

In support of the view that Burchell was uncertain of the identity of the taxon he named *A. heteracantha* it has also been pointed out that Burchell later described *A. litakunensis* which is now regarded as a synonym of *A. heteracantha*. Now *Burchell* 2205, the type specimen of *A. litakunensis*, is a sheet consisting of three sets of specimens collected in 1818, 1819 and 1820, representing stages in growth of the young plants grown by Burchell from seeds of *A. litakunensis*. Burchell collected the seeds from Takun (Litakun) between 24–29th July 1812. No specimen of the original tree of *A. litakunensis* seems to have been preserved by Burchell. In his type description in his Travels 2: 452 (1824), the pods are described correctly. It is difficult to believe that Burchell would have described *A. litakunensis* as a new species had he ever seen the similar spirally twisted pods of *A. heteracantha*. Obviously Burchell believed that *A. heteracantha* and *A. litakunensis* were distinct species. It must be recalled that the

type of *A. heteracantha* is a sterile shoot which displays both short recurved and long straight spines and, apparently, Burchell never saw the spirally twisted pods. On the other hand the armature in the type description of *A. litakunensis* is recorded as "Spinae stipulares geminae breves recurvae". Burchell's type-tree of *A. litakunensis* apparently had only short recurved spines. This is quite possible as not all specimens of *A. tortilis* display a mixture of short recurved and long straight spines. Despite the similarity in growth form of *A. heteracantha* and *A. litakunensis* Burchell obviously saw no reason to believe that his two species, one exhibiting a mixture of short recurved and long straight spines (in itself an unusual feature) and the other exhibiting short recurved spines only but with curiously twisted pods, were one and the same species.

Burchell's comment "Legumen lineare" at the end of his description of *A. heteracantha* was indeed unfortunate for it was this phrase which gave rise to the confusion and uncertainty over the identity of this species. This uncertainty in turn led to yet other species being described which has further complicated the synonymy. The uncertainty over the identity of *A. heteracantha* and subsequent misapplication of the name will now be traced.

Harvey in his key to the *Acacia* species in Fl. Cap. 2: 279 (1862) recorded the pod of *A. heteracantha* as linear and this is repeated under his description of the species on p. 280.

Engler in Bot. Jahrb. 10: 19 (1888) keyed out *A. heteracantha* under the species with linear pods. As Engler believed that *A. heteracantha* had linear pods he considered it necessary to describe *A. spirocarpoides* (1.c.: 23) and *A. maras* (1.c.: 24). He added under his description of *A. spirocarpoides* that this species differed from *A. heteracantha* in having spirally contorted pods. This is confirmed by Marloth in Trans. S. Afr. Phil. Soc. 5: 270 (1889): "There is, however, no specimen known which with safety can be referred to this name (*A. heteracantha*). I thought first that a species pretty common in Griqualand West should be considered to be Burchell's *A. heteracantha*, but the shape of its legumes differs so widely from B's description, that it has been necessary to give it another name (A. spirocarpoides Engler)". Engler maintained that *A. maras* differed from *A. spirocarpoides* in that the pods were constricted between the seeds.

Dinter in Deutsch-Südwest-Afrika Flora Forst-und land-wirtschaftliche Fragmente: 76 (1909) applied the name *A. heteracantha* to plants in the *A. luederitzii* Engl.—*A. reficiens* Wawra complex. This is clear from his description of the pods as 3–4 cm long and $\frac{3}{4}$ cm wide and by his use of the Herero name "Omungondo" for this taxon. All subsequent misapplications of the name *A. heteracantha* to plants in the *A. luederitzii*—*A. reficiens* complex appear to have originated here.

Glover in Ann. Bol. Herb. 1: 151 (1915) included *A. heteracantha* under "Imperfectly known and doubtful species". Glover noted: "Flowering branchlets of *A. spirocarpoides* Engl. seem to me to be identical with those of *A. heteracantha* Burch., but as Burchell's type has no fruit and as he in his notes describes the legume as "linear", I hesitate to unite these two species".

Engler in Die Pflanzenwelt Afrikas 3 (1): 355–357 (1915) discussed *A. litakunensis* and *A. heteracantha* and mentioned that he had not seen the type specimens of either of these species. He expressed doubt as to whether the plant referred to as *A. heteracantha* by Dinter was in fact *A. heteracantha*. Engler concluded that Dinter's plant could just as well be *A. uncinata* Engl. (which it was!). Dinter in his Index Fedde Rep. 15: 80 (1917) once more misapplied the name *A. heteracantha* to plants in the *A. luederitzii*—*A. reficiens* complex.

E. G. Baker in Leg. Trop. Afr.: 822 (1930) keyed out *A. heteracantha* under those species with annular or spirally contorted pods. Bak. f. was unable to separate *A. heteracantha* from *A. tortilis* except by that last report of taxonomists, the geographical discontinuity.

Pönnighaus in J. S. W. Afr. Sci. Soc. 6: 13 (1933) further perpetuated the misapplication of the name *A. heteracantha* for plants in the *A. luederitzii—A. reficiens* complex.

Walter and Volk in Grundlagen der Weiderwirtschaft in Südwestafrika 211, t. 68B (1954) did likewise. The illustration t. 68B shows *A. heteracantha* quite distinctly as having a linear-oblong pod.

The identity of *A. heteracantha* was finally resolved by Brenan in Kew Bull. (1957, 1959). Brenan (1957) regarded *A. spirocarpoides* Engl. and *A. maras* Engl. as synonyms of *A. tortilis* subsp. *heteracantha.* In doing so Brenan mentioned that the type specimens of these two species were destroyed in the Berlin Herbarium and that he was therefore interpreting the two species from their descriptions.

While examining specimens on loan from the Albany Museum, Grahamstown an isosyntype of *A. spirocarpoides*, *Marloth* 839, was found. This confirmed that the species is correctly regarded as a synonym of *A. tortilis* subsp. *heteracantha.* Also in the Albany Museum collection is a specimen of *Marloth* 1260 which is the type number of *A. maras.* However, although the specimen carried the type number, there are certain discrepancies between the information published in the type description in Bot. Jahrb. X: 24 (1888) and the information written on the label. The information published is "Otjimbingue, alt. 900 m—Fructifera m. Junio 1886", while the information on the label is "ad ripas fluminis Kan, pr. Usakos, 860 m., Majo 1886". The date is slightly different as is the locality although admittedly the river Kan runs between Usakos and Otjimbingue. The specimen agrees well with the description of *A. maras* and although I felt somewhat hesitant initially about accepting this specimen as an isotype it seems safe to regard it as a probable isotype.

Bothalia, 10, 4: 555–564

Contribution to the caryological study of the African grass Aristida rhiniochloa Hochst., based on specimens from the Southern Hemisphere

by

Pierre Bourreil*, Alain Geslot*, Monique Gorlier*
and Bernard de Winter†

Abstract

The chromosome number established for *Aristida rhiniochloa* Hochst. by the study of material from three localities in the Southern Hemisphere confirms the results obtained on material from North Africa. The haploid complement (n = 11) and the diploid number (2n = 22) of this species conform to the basic number x = 11 typical for the Aristideae. It is shown that the caryotype of this species is sub-symmetrical. Preliminary studies of material from two localities show that the meiotic behaviour conforms to that found in the diploid species with n bivalents.

Introduction and Acknowledgements

The study of *A. rhiniochloa* Hochst. in the Southern Hemisphere follows similar investigations started on North African material of this species, of which the distribution coincides for the greater part with the Sudan-Angolan phytogeographic region.

We are grateful to O. J. Azancot de Menezes, L. E. Codd and B. K. Simon who kindly made material available for this investigation.

Methods

The study was partly done on material cultivated in a greenhouse in the Botanical Garden of the "Centre de St.-Jérôme" of the University of Provence. The root tips of plants (originally from Angola), were fixed in bichromate of potassium and stained in crystal violet (3). The young panicles of plants (originally from Rhodesia) were fixed in formula 3 of Carnoy (9) and stained in carmine-haematoxylin (1, 2, 5 and 9). The method of application of heat as suggested by Cauderon (10) was used. It is similar to the method usually applied by us, but the material is pre-stained at room temperatures and is only heated over a spirit lamp after squashing in 45% acetic acid or in acetic haematoxylin (2) diluted to 50%. Boiling the liquid must be avoided by passing the slide over the flame fairly rapidly, otherwise chromosome damage may result. Staining proved to be good with both methods and it was possible to study and photograph divisions after more than two months storage in a refrigerator. Slides stored in this way should be repeatedly passed above the flame of a spirit lamp immediately before study of the divisional plates under the microscope. This technique shows the colourless spindle clearly in prometaphase I and metaphase I of the divisions of the microspores (Fig. R1e). The photographs of the prometaphase and metaphase plates were taken by focussing on the chromosomes not the whole spindle. A beautiful spindle-vestige in telophase I of a pollen mother cell is visible in Fig. Rlg.

Results

Caryology of the Angolan material

Origin of material: Mucope (Lat. S., 16° 25', Long W., 14° 50'), Angola. Collected by O. J. Azancot de Menezes. Date of collection: 1968.

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The chromosome number of 2n = 22 was established and confirmed on five different metaphases found in root tip material. (See Fig. A.) The length of the chromosomes vary from 0,6–0,8 μ for short and up to 1,4 for long chromosomes.

Caryology of two collections from Rhodesia

Origin of material: Districts Wankie (near Victoria Falls) and Chiredzi. Collector: J. C. R. Hill. Dates of collection: August, 1969 and March, 1970 respectively.

1. *Chiredzi material*

In a study of pollen mother cells the number n = 11 was established 19 times with certainty on prometaphase I plates. (See Fig. R1c, R1d, R1f), four times on metaphase I plates (See Fig. RIe) and three times on anaphase I plates. The complement 2n = 22 was established seven times on metaphases in ovaries. (See Fig. RIa and R1b). The length of the chromosomes varies from between 0,6 to 1 μ for the shortest chromosomes and 1,3 to 2,8 μ for the longest chromosomes.

2. *Wankie material*

Studies of pollen mother cells made it possible to establish the haploid number n = 11 with certainty on 22 diplotene plates, 91 times in diakinesis (See Fig. R2c), seven times in prometaphase I (See Fig. R2d, R2f, R2e) and six times in metaphase I. In the homeotypic mitosis of the meiotic divisions this haploid number was established 25 times with certainty on prophases II and five times on metaphase II. The chromosome complement of 2n = 22 was established with certainty, at least three times on metaphases in the ovary (See Fig. R2b) and three times on metaphases in the stamens (See Fig. R2a). The length of the chromosomes vary from 1–1,3 μ for the shortest to 2,1–2,8 μ for the longest.

Discussion of the Caryology

Both the haploid and diploid chromosome complements agree with the numbers established in somatic meristems of cultivated plants of this species from North Africa.

The caryotype

The study of the relative size and configuration of the chromosomes will be continued by at least one of us (P.B.) using more appropriate techniques, such as immersion, if necessary, in alphamonochloronapthalene (10), treatment with pectinase i.e. rapidase C (17), staining in Feulgen followed by staining in acetic haematoxylin (9) or in acetic orcein (10). Methods of measuring used by Essad (18), Essad and Najcevska (19) will in addition be used. The measurements set out in Tables 1 and 2 can in the interim be supplied as an indication of the maximum and minimum lengths of the chromosomes treated with different fixatives.

Table 1.—Length of the longest and shortest somatic chromosomes of the root tips (Cr207K2 fixative).

Locality	(a) Length in μ of autosomes of minimum size	(b) Length in μ of autosomes of maximum size	"Ratio" $\frac{b}{a}$	Number of different caryotypes measured
Attakou. Ennedi septentrional..	0,6	1,7	2,8	1
Airport El Obeid (Sudan)......	0,7	1,2	1,7	1
Airport El Fasher (Sudan)......	0,7–1	1,7–2	2,1	2
Angola......................	0,6–0,8	1,4	2,0	2

TABLE 2.—Lengths of the longest and shortest somatic chromosomes of the root tips (Carnoy type fixative).

Locality	Organ Studied	(a) Length in μ of the autosomes of minimum size	(b) Length in μ of the autosomes of maximum size	Ratio $\frac{b}{a}$	Number of different caryotypes measured
Airport of El Fasher (Sudan)..........	basal meristem of leaf...	1,2	2,1–2,6	1,9	2
Chiredzi, District (Rhodesia).......	ovary....	0,6–1	1,3–2,8	2,5	7
Wankie, District (Rhodesia).......	stamen and ovaries..	1–1,3	2,1–2,8	2,1	2

An analysis of Tables 1 and 2 show that the relationship of the lengths of chromosomes of different pairs of autosomes varies from 1 to 2,8. The study of somatic metaphases, furthermore, showed that chromosomes may be distinguished as having meta- or submetacentric centromeres. The caryotype is therefore subsymmetrical. For a definition of the symmetrical caryotype the reader is referred to Stebbins (26).

If the width of the somatic chromosomes are compared it is seen that those of the roots are $\frac{1}{4}$ of the width of those of the leaves the stamens and the ovary. This may almost certainly attributed to the fact that two different fixatives were used.

The meiotic behaviour

The meiotic behaviour of the Rhodesian representatives is of the regular type found in diploid species (i.e. 11 bivalents in prophase I). The differences that exist are only those of relative frequency of the types of bivalents (II straight, II rings, II intermediates: angled, open rings). The frequency of the different types of bivalents and the chiasmata, will be supplied later in tables modelled on those used by Cauderon (10).

In prometaphase I and metaphase I certain bivalents are sometimes separated on the same spindle fibre (Fig. R1d and R1c). Such pseudo-univalents have in fact been observed in certain diplotene stages of two collections from Rhodesia. Our interpretation agrees with that given by Cauderon for a metaphase reduction division of *Agropyrum intermedium* (Host.) P. Beauv. (10) and by Geslot for certain metaphases I in the microspogenesis of *Campanula recta* Dul. (20).

In material from the Wankie district in nearly full prophase I a small spheroidal body, staining as deeply as the nucleolus and the chromosomes, was observed. It is not visible in any prometaphase, metaphase or anaphase plates, but it reappears in telophase. This cycle is shared by the nucleolus and it must therefore be considered as a nucleolus-satellite. This interpretation is supported by the presence of two nucleoli in some somatic cells. Although we have not examined meiotic prophases in the material from the Chiredzi district, it seems probable that this peculiarity is characteristic of the species.

CONCLUSIONS

This study has confirmed that *Aristida rhiniochloa* Hochst. is a diploid with 2n = 22 chromosomes and has contributed information on its caryotype and the meiotic behaviour of the diploids. The chromosome count 2n = 38 for *Aristida rhiniochloa* in Darlington and Wylie (13) does not agree with our results and needs further investigation based on material of the species from the Sudan.

The present study is a preliminary one and should be extended to include a wider range of material to determine whether there are areas in which the species has developed polyploidy. Polyploid series in *Aristida* with 2–4 ploids (*A. fendleriana*, *A. glauca*, *A. longiseta*), 2–4–6–ploids (*A. wrightii*), 2–4–6–8 ploids (*A. purpurea*) have, as far as we know, for the first time been mentioned by de Lisle (14) in studies of material from the south-west United States.

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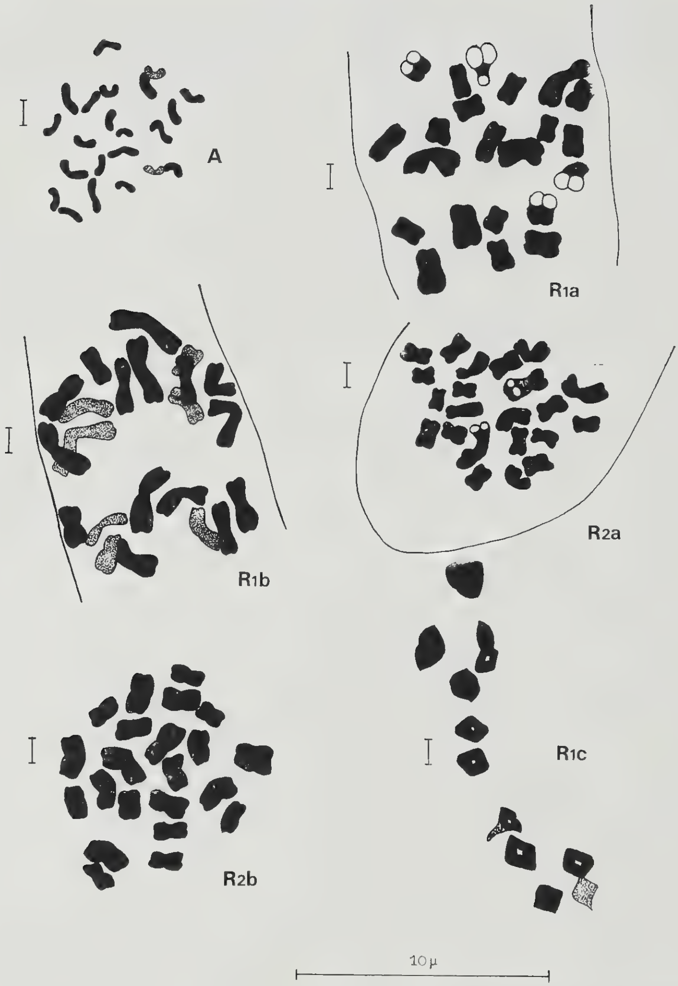

PLATE 1.—Drawings of the chromosome complement of **Aristida rhiniochloa** obtained from cultivated plants.

Origin of the material: A, Angola. R, Rhodesia: R1, Chiredzi district; R2, Wankie district.

Explanation of the phases: Somatic metaphases (2n = 22) of: ovary (R1a, R1b, R2b); the stamens (R2a); the root meristem, (A). Meiosis: prometaphase I (R1c).

Type of association of the chromosomes.—Fig. R1c, 11. IIa (bivalents in rings, association very homogenous).

Note on the drawings. Certain chromosomes are drawn finely speckled to distinguish them from others with which they are in contact; vertical arms are outlined but left white. In heterotypic mitosis, drawing in black makes it difficult to give an accurate presentation of the chromosomes and each bivalent is drawn partially in black and partially in a hatching of black stipples. The vertical line to the left of each drawing represents 1 μ.

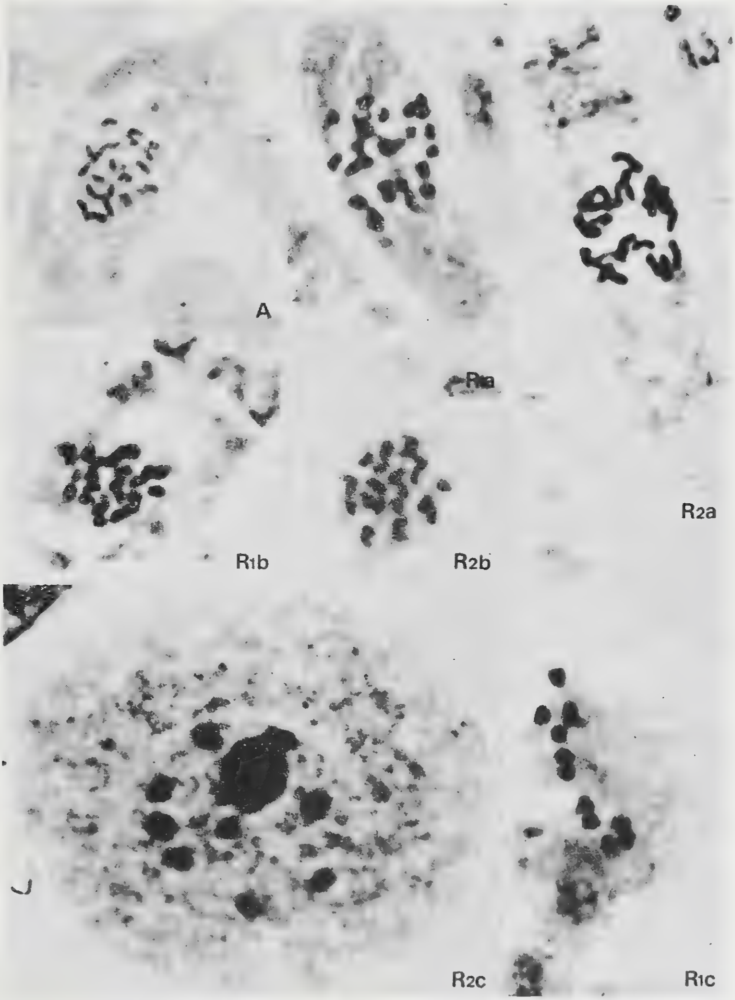

PLATE 1a.—Photographs of the chromosome complements of **Aristida rhiniochloa,** which correspond with the drawings on Plate 1.

ERRATA—For R1b read R2a and for R2a read R1b.

N.B.—Note the absence in R1c of the membrane of the nucleus and nucleolus, as well as the absence of the achromatic spindle, also the bivalents which are aligned close together lengthwise in the cell corresponding to the position of the future spindle, not on the equatorial plane (characteristic of prometaphase I). Note in R2c (diakenesis, n = 11) the trace of the nuclear membrane and the deeply stained nucleolus which is much larger than the chromosomes.

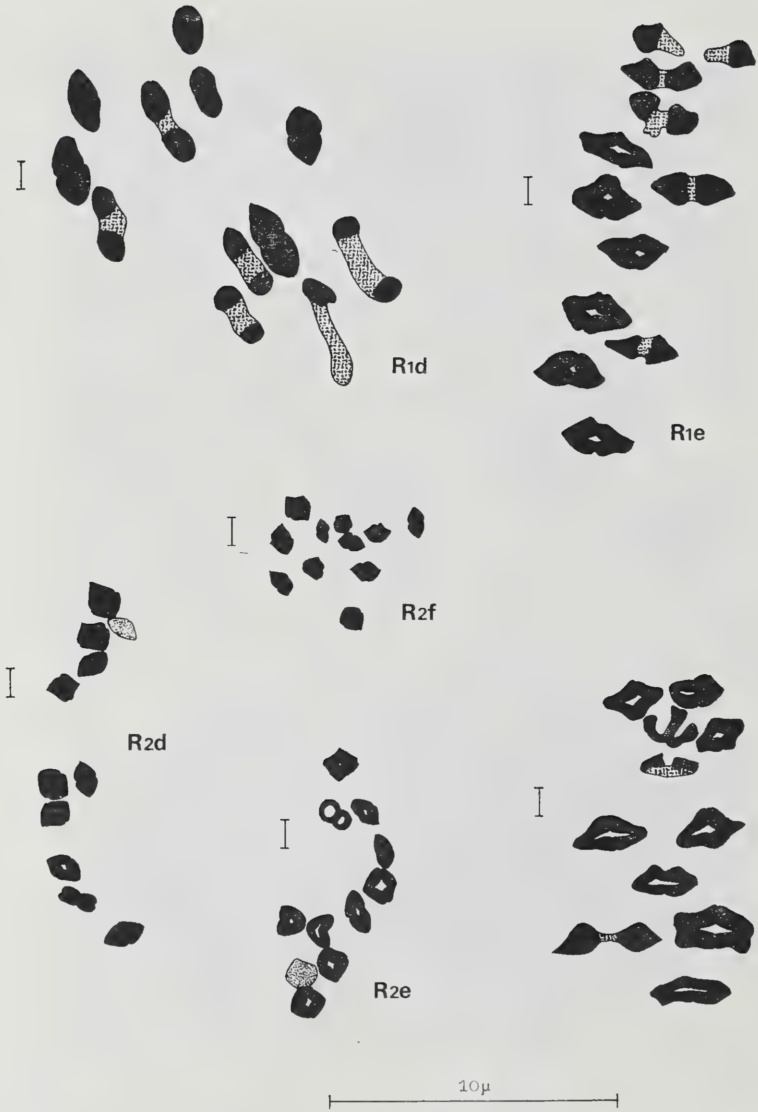

PLATE 2.—Drawings of the haploid chromosome complement (n = 11) of **Aristida rhiniochloa** obtained from cultivated specimens.

(For origin of material and notes on the drawing see Plate 1).

Explanation of the phases of the meiotic divisions of the pollen mother cells: Prometaphase (R1d, R1f, R2d, R2e, R2f); metaphase (R1e). N.B. In R1d the lowest bivalent forms a very open "elbow".

Type and association of the chromosomes:

Fig. R1d, 4IIa + 1 IIa. dis. + 6 II dr.c.... = 11 bivalents (association less homogeneous).
Fig. R1e, 6IIa. + 4 IIa.o. + 1 II dr.dis.... = 11 bivalents (association fairly homogeneous).
Fig. R1f, 8IIa. + 3 IIa.o............... = 11 bivalents (association homogeneous).
Fig. R2d, 10 IIa. + 1IIdr............... = 11 bivalents (association fairly homogeneous).
Fig. R2e, 11 IIa....................... = 11 bivalents (association very regular).
Fig. R2f, 11 IIa....................... = 11 bivalents (association very regular).

Explanation of synbols: II = bivalent; a = a ring; a.o. = an open ring (the ring may be open from the start or more often the chiasmata may have been released in the twisting during prophase); a. dis. = ring separated into two chromosomes (pseudounivalents); dr. = straight; dr.c. = arms straight forming an "elbow"; dr. dis. = straight, separated.

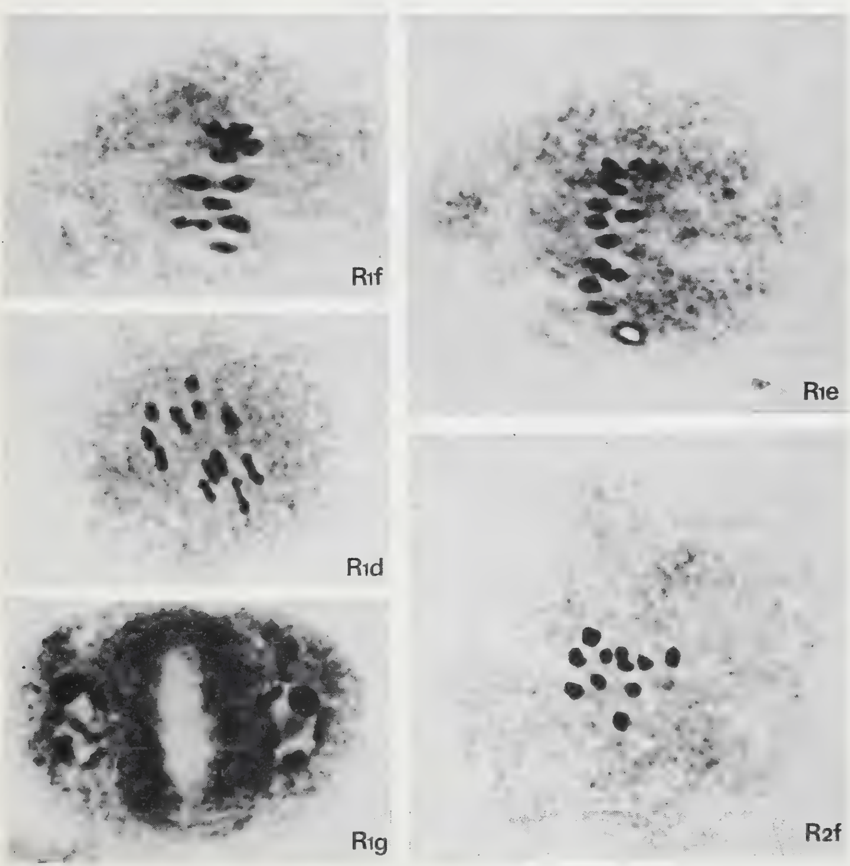

Plate 2a.—Photographs of the haploid chromosome complements (N = 11) of **Aristida rhiniochloa** corresponding to the drawings in Plate 2. Note in addition a telophase I (R1g).

73472—5

Bothalia, 10, 4: 565–574

New and Interesting Records of African Plants

by

Various Authors

CELASTRACEAE

Pseudosalacia *Codd*, gen. nov., *Salaciae* L. affinis, sed staminibus 5 prope margine disci insertis differt; a *Cassini* L. fructibus 2–5-seminalibus demum dehiscentibus differt.

Arbor. *Folia* alternantia, petiolata, exstipulata. *Inflorescentia* axillaris pauciflora cymosa, breviter pedunculata vel fasciculata, bracteis minutis deciduis. *Flores* hermaphroditi pedicellati. *Sepala* 5, imbricata. *Petala* (4—) 5 (—6), patentia. *Discus* applanatus. *Stamina* 5, prope margine disco inserta. *Ovarium* superum, in disco immersum, 3-loculare, loculis 2-ovulatis, ovulis collateralibus erectis, stylo 1, stigmate non distinguibili. *Fructus* capsularis coriaceus demum loculicidaliter dehiscens. *Semina* 2–5. *Endospermum* praesens.

Type species: *Pseudosalacia streyi* Codd.

Pseudosalacia streyi *Codd*, sp. nov., species unica.

Arbor 3–5 m alta, ramulis cinereis glabris. *Folia* petiolata coriacea cinereo-viridia glabra; lamina oblongo-elliptica vel ovato-elliptica, 7–14 cm longa, 4–8 cm lata, penninervia apice rotundata vel emarginata, basi obtusa, margine integra, petiolo 6–12 mm longo. *Inflorescentia* breviter pedunculata vel fasciculata 1–7-flora, pedicellis 1–2 cm longis. *Sepala* 5, ad basim conjuncta persistentia. *Petala* (4—) 5 (—6), viridi-flava vel flava patentia subrotundata, ca. 3 mm diam., subintegra. *Discus* carnosus obscure 5-angulatus. *Stamina* 5, petalis alternantia, subsessilia, prope margine disco inserta. *Ovarium* 3-loculare, in disco immersum, stylo brevissimo. *Fructus* globosus, 2–3 cm diam., pericarpio crasso coriaceo brunneo minute verruculoso. *Semina* 2–5, brunnea glabra trigona, 8–12 mm longa.

Type: Natal, Port Shepstone District, Uvongo River, about 5 km from the sea, 22 Oct. 1969, *Strey* 9150 (PRE, holo.).

Tree 3–5 m tall; bark greyish, smooth; branchlets glabrous. *Leaves* petiolate, coriaceous, grey-green, glabrous; blade oblong-elliptic to ovate-elliptic, 7–14 cm long, 4–8 cm broad, penninerved; apex rounded to emarginate, base obtuse; margin entire, slightly thickened; petiole 6–12 mm long, channelled above. *Inflorescence* shortly pedunculate or fasciculate, 1–7-flowered; pedicels 1–2 cm long; bracts minute, scale-like. *Sepals* 5, united at the base, imbricate, triangular, 1–1,5 mm long, persistent and reflexed at the fruiting stage. *Petals* (4—) 5 (—6), greenish yellow to yellow, spreading, subrotund, ca. 3 mm in diameter, subentire. *Disc* fleshy, obscurely 5-angled. *Stamens* 5, alternating with the petals, subsessile, arising from small protuberances near the margin of the disc. *Ovary* 3-locular, almost completely immersed in the disc; locule 2-ovulate; ovules collateral, erect; style 1, very short; stigma not distinguishable. *Fruit* capsular, globose, 2–3 cm in diameter, eventually dehiscent; pericarp thick, leathery, dark brown, minutely verruculose. *Seeds* 2–5, brown, glabrous, trigonous, 8–12 mm long; endosperm present.

For some years sterile specimens of this interesting small tree have been known from the south coastal area of Natal and it is largely due to the persistence of Mr. R. G. Strey, Curator of the Natal Herbarium, that the fruits (in 1965) and flowers (in 1966) became known. More recently, excellent flowering and fruiting specimens have been collected by Mr. Strey and by Mr. H. B. Nicholson of "Skyline", St. Michaels-on-Sea, Port Shepstone District.

PLATE 1.—**Pseudosalacia streyi:** Above, flowering twig, x4; below, fruits, $\times\frac{3}{5}$.

PLATE 2.—**Pseudosalacia streyi,** fruiting branch, x1 (*Strey* 9150).

The fruits are hard, leathery, globose, 2–5-seeded capsules, eventually dehiscing in three valves and are reminiscent of some *Salacia* species. The flowers differ from *Salacia* in having 5 stamens which arise from small protuberances near the margin of the disc. In *Salacia* there are usually 3 stamens (rarely 2 or 4) which are borne inside the disc, around the base of the ovary.

Flowering specimens resemble some species of *Cassine* sens. lat., and the alternate leaves suggest an affinity with *C. aethiopicum* Thunb. The fruits of *Cassine* are, however, drupaceous and almost invariably 1-seeded, while the five stamens are borne outside the disc.

Specimens were sent to our Liaison Officer at Kew who, after consultation with Dr. N. K. B. Robson, reported that it did not satisfactorily fit into a known genus.

The tree is relatively rare, occurring on river banks in the Port Shepstone District not far from the sea, usually among rocks.

NATAL.—3030 (Port Shepstone): Uvongo River, about 5 km from the sea (—CD), *Strey 9150; 9240*; *Nicholson s.n.*; Izotsha River (CD), *Strey 6860; 7559; Ross 1887.* 3130 (Port Edward): Umtamvuna River (—AA), *Strey 5835; 7250.*

L. E. CODD

CUCURBITACEAE

A New Combination in Zehneria

Jeffrey in Kew Bull. 15: 343 (1962) realigned some of the generic limits within the tribe Melothrieae Endl. The most important consequences of this realignment were the re-establishment of the genus *Zehneria* Endl., which is characterized by its three 2-thecous stamens, *Solena* Lour. by its peculiar obliquely triplicate anther-thecae, and *Mukia* Arn. by its tumid seeds and clustered flowers, as distinct from *Melothria* L. into which they had been sunk by Cogniaux (Cogniaux in De Candolle, Monographiae Phanerogamarum 3, 1881). *Melothria* L. is then left as an entirely New World genus of plants with long-stalked fruits and male racemes, compressed seeds, and three stamens, two of which are 2-thecous and the other 1-thecous.

Of the five southern African species of *Melothria* dealt with by Meeuse in Bothalia 8: 13–21 (1962), four have already been transferred either to *Mukia* or to *Zehneria* by various authors. However, *Melothria parvifolia* Cogn. appears to have been overlooked. Examination of specimens indicated that the species should be placed in the genus *Zehneria* and this opportunity is taken of effecting the necessary combination.

Zehneria parvifolia (*Cogn.*) *J. H. Ross*, comb. nov.

Melothria parvifolia Cogn. in Bull. Herb. Boiss. 3: 420 (1895); Burtt Davy in Fl. Transv. 1: 225 (1926); Meeuse in Bothalia 8: 18 (1962). Syntypes: Natal, Durban, *Rehmann* 8839, 8842 (Z).

Zehneria parvifolia has been recorded from Mozambique, the Transvaal and Natal. As Meeuse (*l.c.*) cited an adequate selection of specimens it is not considered necessary to cite the specimens again here.

J. H. Ross

FLACOURTIACEAE

Trimeria rotundifolia or T. grandifolia?

For a long time *Trimeria rotundifolia* (Hochst.) Warb. and *T. grandifolia* (Hochst.) Warb. have been considered conspecific and there seems to be no doubt that this is the case. *Monospora rotundifolia* Hochst. and *M. grandifolia* Hochst. were published simultaneously in the same publication, namely Flora 24: 661 (1841). In choosing one or other of the epithets, it is obligatory, according to Article 57 of the Code (1966), to accept the choice of the first author who sunk one of the species under the other. Milne-Redhead in Kew Bull. 1939: 34 (1939) presented a good case for the adoption of the epithet *rotundifolia*, since this was the epithet chosen by Gilg in Engl., Pflanzenw. Afr. 3,2: 582 (1921) who, according to Milne-Redhead, was the first to unite *Trimeria rotundifolia* and *T. grandifolia*. Subsequently most botanists seem to have used the name *T. rotundifolia*.

However, during discussions with Dr. H. Sleumer of the Rijksherbarium, Leiden, who is revising the Flacourtiaceae for the Flora of Tropical East Africa, it was learned that Gilg was not the first to unite *T. rotundifolia* and *T. grandifolia*: it was actually Durand and Schinz in their Consp. Fl. Afr. 1: 226 (1898), 23 years earlier, and they chose the epithet *grandifolia*. The name *T. grandifolia* must therefore be used for the combined species. The author is indebted to Dr. Sleumer for pointing this out to him.

D. J. B. Killick

MYRTACEAE

A New Species of Eugenia from Pondoland and Southern Natal

Eugenia erythrophylla *Strey*, sp. nov., ab speciebus africanis australibus omnibus distincta.

Arbor vel arbuscula, 3–10 m alta; rami brunnei, adultis griseis, ramis et foliis juvenilibus roseis albo-pilosis glandulosis. *Folia* opposita, usque 12 cm longa, viridia, coriacea, obovata vel obovato-lanceolata, glandulosa, basi cuneata, margine revoluta, apice acuminata vel obtusa vel rotundata, nervis superne prominentibus, lateralibus 6–8 prope marginem conjunctis, nervis subtus leviter prominentibus; petioli 2–6 mm longi, melano-rugulosi. *Flores masculi* sessiles vel subsessiles; inflorescentia albo-pilosa, pauciflora vel pseudo-racemosa abbreviata vel congesta; bracteae 2–4 mm longae, ciliatae, caducae, receptaculum turbinatum, 2 mm longum, tomentosum; sepala 4, late rotundata, 3–5,5 mm longa, superne pauci-pilosa, subtus subglabra; petala 4, obovata, 6–7 mm longa, glabra, margine ciliata; discus subcupulatus, dense pilosus; stamina numerosa, filamentis 4–5 mm longis libris omnibus antheriferis; antherae 2-thecae, 1–1,3 mm longae, versatiles, loculis longitudinaliter dehiscentibus; ovarium abortivum; stylus 1 mm longus; stigma abortivum. *Flores hermaphroditae* subsessiles vel breviter pedicellatae, solitariae, axillares, valde ramis abbreviatis; bracteae 2,5 mm longae, caducae; bracteolae 2, glabrae; receptaculum adnatum; sepala et petala ut in floribus masculis vel aliquid majora; receptaculum obconicum, 4 mm longum; gynoecium in receptaculum profunde immersum; discus planus, carnosus, papillosus vel pilosus; stamina numerosa; filamenta 3–5 mm longa, filiformia, glabra, libra, omnibus antheriferis; antherae 2-thecae, 1 mm longae, versatiles, loculis longitudinaliter dehiscentibus; ovarium 2-loculare, ovulis in quoque loculo 2 evolventibus 1 vel 2; stylus filiformis, 8 mm longus, glaber; stigma discoideum minutum; baccae subglobosae, apice calycum lobis 4 persistentibus, 2–2,5 cm longae, 1,8–2,5 cm diam., juvenilibus pilosis vel puberulis, adultis glabrescentibus; semina globosa, 1–1,5 cm diam., brunnea.

Type: Cape, 3129 (Port St. Johns): Goss Point (–BD), *Strey* & *Nicholson* 10100⚥ (NH, holo.). Fig. 1.

Tree 3–10 m tall; branches brown, becoming grey when mature; young shoots and leaves pinkish, densely whitish pilose, becoming glabrous with age. *Leaves* opposite, petiolate, coriaceous, green at maturity, gland-dotted, obovate to obovate-oblanceolate or elliptic, 6–12 cm long; 3–7 cm broad, cuneate at the base, apex abruptly acute or obtuse to rounded, margin revolute, midrib conspicuous, lateral nerves in 6–8 pairs, spreading, slightly prominent below, joined near the margin; petiole 2–6 mm long, blackish, rugulose. *Male flowers* sessile or subsessile, congested on abbreviated shoots which occasionally develop as leafy shoots; bracts 2–4 mm long, ciliate, caducous. *Calyx* united at base; tube broad, more or less saucer-shaped, 2 mm long, densely pubescent; lobes 4, subrotund, 3–3,5 mm long, sparingly pubescent below, subglabrous above. *Petals* 4, obovate, 6–7 mm long, glabrous, margin ciliate. *Disc* saucer-shaped, densely pubescent. *Stamens* numerous, arising from the disc; filaments of various lengths, 4–5 mm long, free to the base; anthers 2-thecous, versatile, 1–1,3 mm long, all fertile. *Ovary* abortive; style rudimentary, 1 mm long; stigma absent. *Hermaphrodite flowers* subsessile to shortly pedicellate (pedicels up to 8 mm long), usually solitary, axillary, occasionally on short abbreviated shoots; bracts 2,5 mm long, caducous; bracteoles 2, attached at the base of receptacle, 2,5 mm long, glabrous. *Calyx and petals* as in male flowers, but somewhat larger; calyx tube obconical, 4 mm long. *Disc* flat, fleshy, densely pubescent. *Stamens* numerous, arising from the disc; filaments of various lengths, 3–5 mm long, free to the base; anthers 2-thecous, 1 mm long, with white membranous fringe, broadly rectangular. *Ovary* immersed in the disc, 2-celled; ovules 2 per cell, 1 or 2 developing; style filiform,

FIG. 1.—**Eugenia erythrophylla.** 1, longitudinal section of hermaphrodite flower, x 3; 2, longitudinal section of male flower, x 3; 3, bracts, calyx and style of hermaphrodite flower, x 3; 4, longitudinal section of fruit, x 2.

glabrous, 8 mm long; stigma small, discoid. *Fruit* obovoid to subglobose, 2–2,5 cm long, 1,8–2,5 cm diam., glabrescent, with persistent calyx lobes at the apex. *Seeds* globose, 1–1,5 cm diam., brown.

This new species of *Eugenia* was discovered only recently in coastal montane forest at several localities in Pondoland and southern Natal. The plant is usually found in rocky situations near streams or along the upper edge of Table Mountain Sandstone cliffs.

NATAL.—3130 (Port Edward): Farm Beacon Hill (–AA), *Strey 7225; Ross 1850;* Umtamvuna Forest Reserve (–AA), *Nicholson s.n.* 3030 (Port Shepstone): Izotsha (–CD), *Strey & Nicholson 7171;* Mgongono (–CD), *Strey & Nicholson 7611; 80.6; 9295; Cooper 27;* Uvongo Nature Reserve (–CB), *Strey & Nicholson 10348*⚥.

CAPE.—3129 (Port St. Johns): Goss Point (–CB), *Strey & Nicholson 10100*⚥; Lupatana (–BD), *Strey & Nicholson 10240*♂; Mkambati Waterfall (–BD), *Strey 8575;* Magwa Falls (–BD), *Jenkins s.n*

E. erythrophylla is an erect, medium-sized tree, 3–10 m high, with a straight bole which, in older trees, is sometimes fluted and twisted. The branches are rather widely spaced. The bark is thick, light grey, scaling irregularly and very finely striate. On older branchlets the bark is ash-grey, exfoliating in thin strips. The young shoots are very distinctly reddish-velvetty at the growing tips. The slash is rich dark brown.

The species appears to have no close affinity in South Africa.

R. G. STREY

STERCULIACEAE

A NEW SPECIES OF HERMANNIA

Hermannia muirii *Pillans*, sp. nov. distinctissima, speciebus stipulis foliaceis pertinens.

Frutex effusus 3–5 dm altus; rami sparse hispidi et stellato-pubescentes. *Folia* 0.6–1 cm longa oblongo-oblanceolata vel oblonga, integra, sessilia, pilis simplicibus vel stellatis ciliata, supra et infra pauce pilis simplicibus munita. *Stipula* foliis simulantibus sed 5–8 mm longa. *Flores* fasciculati, terminales. *Pedunculi* subsessiles, 3-flori. *Pedicelli* ad 3 mm longi, sparse setosi. *Bracteae* 0.4–1 cm longae, lineari-lanceolatae pilis setaceae simplicibus ciliatae. *Calyx* 6 mm longus, extus pilis rectis setaceis stellatis, 1–1.5 mm longis paratus; tubus cyathiformis; lobi tubo aequilongi anguste deltoidei, acuminati, subacuti, sparse intus pubescentes. *Petala* 6–7 mm longa, albida, lamina 3.5 mm longa, obovata glabrata; unguis lamina subequilongus, cuneatus basi angustatus dorsalis partim minute stellato-pubescens. *Filamenta* 3–3.5 mm longa, oblongo-obovata glabrata. *Anthera* 2.5 mm longa lanceolata, obtusa, minute ciliata. *Ovarium* ellipticum angulis pilis setaceis, inter angulos pilis brevioribus pubescentibus. *Styli* basi setosi. *Capsula* 4 mm longa, late elliptica vel subrotunda angulis pilis setaceis, inter angulos pilis brevioribus. *Semina* minute scabrida.

CAPE.—Riversdale District, Droogeveldvlakte, *Muir* 1882 (BOL, holo.; PRE, iso.).

A much branched spreading shrub, 3–5 dm high; stems woody about the base, rigidly wiry with spaced long or short stellate or simple hairs. *Leaves* mostly 0.6–1 cm long, oblong-oblanceolate or oblong, shortly acute or obtuse, entire, sessile, ciliate with coarse stellate or simple hairs, with a few similar hairs on the dorsal or ventral surface. *Stipules* mostly 5–8 mm long, broadly oblong- or ovate-lanceolate, obtuse or subacute, coarsely ciliate. *Flowers* in dense terminal clusters. *Peduncles* subsessile, usually 3–flowered. *Pedicels* up to 3 mm long, with dispersed coarse hairs. *Bracts* 0.4–1 cm long, linear-lanceolate, with simple coarse cilia. *Calyx* 6 mm long, with abundance of straight, coarse, pale, stellate hairs 1–1.5 mm long on the outer surface; tube cyathiform; lobes as long, narrowly deltoid tapering to a subacute apex, sparsely pubescent on the ventral surface. *Petals* 6–7 mm long, white; limb 3.5 mm long, obovate, glabrous; claw almost as long, cuneate, tapered to the base, minutely stellate-pubescent behind the upper margins. *Filaments* 3–3.5 mm long, oblong

about the base gradually widening upwards to shortly above the middle thence gradually tapering to the apex, glabrous. *Anthers* 2.5 mm long, lanceolate obtuse, with short cilia on the cells. *Ovary* elliptical, with coarse erect hairs on the angles and apex with fewer small hairs between the angles. *Styles* setose about the base. *Capsule* 4 mm long, broadly elliptic or subrotund with coarse stellate hairs on the angles, with small stellate hairs between. *Seeds* minutely scabrid.

This distinct species belongs to the comparatively small group having leaves and stipules very similar in shape. It is readily distinguished from *H. orophila* Eckl. & Zeyh., a species which is in the same group and which occurs in the same area, by the absence of distinct serrations or teeth on the leaves.

The above description and notes were taken from the manuscript of the late Mr N. S. Pillans of the Bolus Herbarium, whose work on a revision of the genus Hermannia was interrupted by his untimely death.

Investigation undertaken subsequently has shown that the species is locally common in successive valleys south of Albertinia in the Riversdale district.

Two New Varieties of Hermannia filifolia

Hermannia filifolia *L.f.*, Suppl. 302 (1781). Type: Cape, *Thunberg* s.n. (S, holo.; PRE, photo.).

(1) var. **grandicalyx** *Verdoorn*, var. nov.

H. linifolia sensu Eckl. & Zeyh., Enum. 371 (1934); sensu Harv. in Fl. Cap. 1:194 (1860), non Burm.f.

Haec varietas a typica floribus majoribus, calycibus fere petalis equilongis et quam petalis palidioribus saepe cremis, foliis subcarnosis vel non-nunquam subsucculentis et glaucis, internodiis longioribus plurumque glabris et nitidis differt.

Type: Cape, Prince Albert, *Acocks* 17098 (PRE, holo.).

The most diagnostic feature of this variety is the large calyx which is about as long as, and much paler than, the usually dark red petals. It is pale pink or more often cream coloured, finely stellate pubescent and lobed to just beyond the middle with the lobes long-acuminate to the apex. The leaves are inclined to be succulent and glaucous but this feature is not constant for in some of the intermediate specimens the leaves are firmly fleshy as in the typical variety. The plant is usually heavily browsed and the shoots that spring from the woody stump are characterised by long, usually glabrous and shiny internodes. Another feature that may assist in distinguishing this variety is that the capsule is usually somewhat longer, up to 12 mm long, as against the 6–7 mm long capsule of var. *filifolia*, and 7–8 mm long in var. *robusta*.

The description in the Flora Capensis of *H. linifolia* fits this variety and the two specimens cited, *Drege* 7285 (LE, W) and *Ecklon & Zeyher*., Enum. No. 371 (L, S, W) belong here. Harvey doubtfully ascribes the species to Linnaeus but Burmann filius is the author. An examination of Burmann's type, kindly sent on loan to this Institution by the Director of the Conservatoire Botanique at Geneva, revealed that it was conspicific with the type of *Mahernia scoparia* Eckl. & Zeyh.

Harvey mentions that his concept of *H. linifolia* is "nearly allied to *H. filifolia*". A study of the complex has led to the conclusion that it is merely a variety of *H. filifolia*. While it is readily distinguished in the main area of its distribution there are bordering specimens that are not so distinct.

The area of distribution of this variety stretches from Montagu eastwards to Oudtshoorn and northwards to Sutherland and Beaufort West. The largest concentration has been recorded from the vicinity of Prince Albert.

CAPE.—3220 (Sutherland): Klein Roggeveld (-DC), *Marloth 9584*. 3221 (Merweville): Vindragersfontein (-DB), *Acocks 14328;* about 5 km N. of Prince Albert Road Station (-DC), *Acocks 17098*. 3222 (Beaufort West): Doornboomfontein (-AA), *Van Breda 527*. 3320 (Montagu): Josephskraal (-BA), *Van Breda 2123*; about 18 km W. of Laingsburg (-BA), *Acocks 24351;* Matjesfontein (-BA), *Cannon* 166; about 6 km N. of Matjesfontein (-BA), *Comins* 1090; Jakkalsfontein (-DA), *Van Breda 1238*. 3321 (Ladysmith): southern foot of Sevenweekspoort (-AD), *Edwards 2260;* 32 km W. of Prince Albert (-BC), *Leistner 243;* about 10 km S. of Ladysmith (-CB), *Acocks 14611;* Klein Karroo (-CD), *Muir 3754*. 3322 (Oudtshoorn): S.W. of Prince Albert (-AA), *Taylor 7330;* Zwartberg (-AA), *Bolus 11443;* Tygerberg (-AB), *Marloth 4458;* N. of Oudtshoorn (-AC), *Bolus 11722;* Zebra (-CB), *Van Breda 510*.

(2) var. **robusta** *Verdoorn*, var. nov., a var. typica omnibus partibus robustioribus differt; a var. *grandicalyce* foliis densioribus firmioribus ramulis et calycibus scabrioribus differt.

Type: Cape, Port Elizabeth, 2 km N.W. of Donkin Memorial, *Olivier* 458 (PRE, holo.).

This variety is so much more robust than the majority of specimens in the typical variety that at first glance it appears to be specifically distinct. But on examination it is found to agree in the characteristic leaves, pubescence and colouring of var. *filifolia*, differing only in the size of all its parts. The plant is up to 1 m tall and the branchlets are rough with minute scales or the tubercle-bases of fallen hairs. The fascicled ericoid leaves (appearing narrowly linear in pressed specimens), together with their leaf-like stipules are 10–20 mm long and are more crowded on the branches. From var. *grandicalyx* it differs mainly in that the leaves are always firm (not subsucculent) and crowded, without long glabrescent and shiny internodes, and the calyx is not so markedly pale nor finely stellate pubescent but is rough with fairly sparse minute scales or tubercles.

Except for a few intermediate specimens in the surroundings, var. *robusta* has to date been recorded only from the Port Elizabeth district. The specimen of *Zeyher* 2004 in the National Herbarium, Pretoria, labelled as from the "Wintersbergen", is this variety. It is cited in Flora Capensis under *H. filifolia*. However, the same number, *Zeyher* 2004, in the Stockholm Herbarium is rather *H. flammea* and is labelled to be from "Adow & Zwartkopsrivier". In some cases these old specimens are rather confusing and must be treated with caution.

CAPE.—3325 (Port Elizabeth): Victoria Park (-DC), *Long 792;* Baakens River (-DC), *Long 475; Galpin 9930;* 2 km N.W. of Donkin Memorial (-DC), *Olivier 458; 458a*.

I. C. VERDOORN

Bothalia, 10, 4: 575—578

Vegetative Multiplication of *Strelitzia reginae* and its Allies

by

R. A. Dyer*

Abstract

In the past it has been assumed that individual plants of *Strelitzia reginae* Ait. and its allies increase in size by suckering from the base. This proves to be incorrect and it is seen to be by the dichotomous branching of the rudimentary stem axis.

The ideal study of *Strelitzia reginae* Ait., would be to follow the development of a seedling to its maturity. It is intended that this should be done as part of a comprehensive project on the genus *Strelitzia* which is being undertaken at the University of Port Elizabeth under Prof. J. G. Small.

The present note is the outcome of observations stimulated by the "Comments on *Strelitzia*" published in Baileya Vol. 17, p. 65., 1970, by H. E. Moore and Peter A. Hyypio of the Bailey Hortorium, Cornell University.

The distichous production of leaves is to be observed in quite a number of genera of Monocotyledons. *Strelitzia* is one of them. The leaves arise distichously from the rootstock of the acaulescent species and from the stems of caulescent species, that is, the youngest leaf is produced opposite the previous one to form a pair. In bulbs and the arborescent species of *Strelitzia* the process is more or less indefinite, whereas in the acaulescent species of *Strelitzia* it is finite.

In *Strelitzia reginae* Ait. and *S. juncea* Link (sensu stricto) and their allied forms, 2–4 pairs of leaves are produced distichously in the usual manner to form a 'fan'. At the crucial stage of subdivision the innermost two leaves emerge back to back from the axils of the next older leaves. The two innermost back-to-back leaves then become the first leaves (eventually the outermost) of 2 new shoots and so the process of dichotomous subdivision is initiated and continues by repetition. There is no continuation of growth between the back-to-back leaves. Once subdivision begins, displacement of the older leaves takes place and obscures their distichous origin. Inflorescences may emerge from the axis of one or more of the median leaves of the 'fan'.

In one exceptional case the petioles of the two innermost leaves of a "fan" of *S. reginae* were fused along their backs, but normal leaves emerged from the axis of each to initiate the growth of 2 new fans.

It is hoped that the two illustrations will make the principle of the vegetative multiplication clear.

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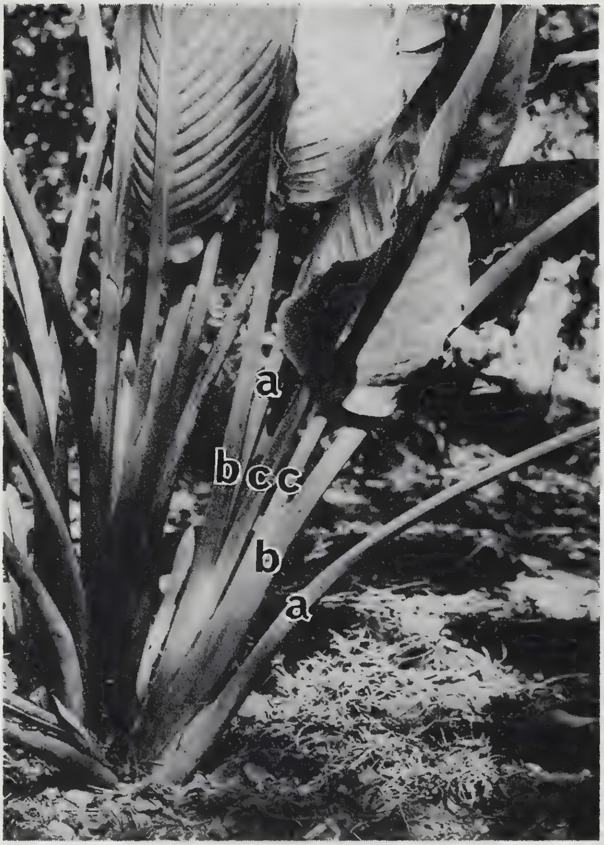

PLATE 1.—**Strelitzia reginae:** aa, outside pair of leaves of the "fan"; bb, next pair of leaves facing each other; cc, next pair of leaves (innermost pair) back to back.

PLATE 2.—**Strelitzia juncea**: aa, outside pair of leaves of the 'fan'; bb, next pair of leaves facing each other; cc, next pair of leaves facing each other; dd, next pair of leaves (innermost pair) back to back; ee, first young leaves of 2 new 'fans'; x, scape of the inflorescence.

Bothalia, 10, 4: 579–582

An Apparatus for Facilitating the Manual Tabulation of Phytosociological Data

by

P. J. Müller,* M. J. A. Werger,* B. J. Coetzee,* D. Edwards* and N. G. Jarman*

Abstract

Attempts by various continental workers to mechanize and facilitate compilation of Braun-Blanquet phytosociological tables from raw data are shortly reviewed and a new apparatus for this purpose is described. The apparatus consists of a table with aluminium channels in which different headed rivets can be placed, symbolizing cover-abundance values. With this apparatus phytosociological tables can be compiled in two stages.

In phytosociological techniques, especially those developed by the Zürich-Montpellier School, the manual ordering of stands and species for preparing the synthesis tables by rewriting has always been a time consuming procedure and a potential source of errors.

The usual method of table preparation in the Zürich-Montpellier School was described in detail by Ellenberg (1956). Shortened English and French translations of the procedure were given by Küchler (1967) and Gounot (1969), respectively.

Attempts to simplify and mechanize the tabulation procedure have been made by several workers. Wilmanns (1959) described a method using small wooden blocks with holes bored through them. Cover-abundance figures were written on each block and the sequence of stands or species was changed by putting a rod through the holes and moving the entire row or column. The method appears to be useful only with small numbers of stands and species, up to about 60 of each. Another disadvantage is that during tabulation the set must be handled very carefully, because one block out of place could easily result in disarrangement of the table structure. This is particularly so when several rows or columns are simultaneously removed from their positions and movability of all those remaining has to be retained. Similar considerations also apply to Margl's (1967) table.

Ellenberg & Christofolini (1964) suggested the use of visual 'punch cards'. The species present in each relevé were punched on one card. Cover-abundance values were marked by symbols around each hole. On a light-table the cards were then compared one by one with a 'standard' card on presence alone. The 'standard' card can be chosen at random. Ellenberg (1968) described a modification of this technique, where cover-abundance values for each of the species were punched as logical sums. These techniques proved to be useful where the vegetation has already been largely classified and the vegetation units described, and where only additional relevés needed to be arranged and included in the existing data material. They may, however, not be readily applicable to data of virtually unknown areas.

Sophisticated techniques for tabulation by computer were recently developed by Stockinger & Holzner (1970) and by Spatz & Siegmund (1971). These methods seem to be particularly useful for the objective and rapid processing of a vast amount of stand and species data. When the amount of data is not too large, and the time spent in preparing the data and the cost of operating the computer are important considerations, the apparatus presented here should prove useful.

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We developed an apparatus which can be used to rearrange and order a matrix without the need to rewrite the various stages described by Ellenberg (1956) in the normal tabulation method. In the present case the apparatus was designed to handle a matrix of up to 124 × 130.

As columns or rows in the usual table matrix, we used aluminium channel, 8 mm wide, 5 mm high and 100 cm long, in which every 8 mm a 3 mm diameter hole, was drilled, thus resulting in 124 holes per channel. Rivets, 3 mm in diameter, ±12 mm long, with cheese-heads of 7 mm diameter, fitted into the holes. The heads of the rivets were sprayed in different colours, symbolizing different cover-abundance values. The advantage of using aluminium channels with rivets in lieu of blocks is that, if one rivet is accidently removed, then the rest of the arrangement cannot be affected as a result.

The channels fitted into the raised edges of a table measuring 100 cm wide and 120 cm long. At one end the channels fit under a flat aluminium bar fixed to that edge of the table, and at the other end they can be fitted under a moveable flat aluminium bar, thus providing extra stability when an arrangement of the channels has been completed or is interrupted. To enable the channels to slide smoothly, they are supported by five metal edges let into the table surface.

For tabulation of the data two such tables should be available. From the field data the raw phytosociological table is set up on the first table, using a channel for either a species or a stand, and the different coloured rivets for cover-abundance values. The channels are then arranged in the desired sequence. The second table is placed so that the direction of the channels is perpendicular to that of the one in the first table, and the pattern of the first table is copied on to the second table. If in the first table the species (rows) were arranged, stands (columns) can now be shifted on the second table or vice versa. In this way the complete phytosociological table can be quickly arranged in two stages, without rewriting being necessary, thus avoiding an important potential source of errors. The end result can be copied in writing from the second table. The apparatus can also be used for processing other data as the sprayed rivets can be used to represent symbols for life forms, habitat features, and other meaningful ecological variables.

We wish to acknowledge the technical assistance of Mr. N. L. Galpin.

Samevatting

Pogings deur verskillende kontinentale werkers om die samestelling van Braun-Blanquet-plantsosiologiese tabelle uit veldgegewens, te meganiseer en te vergemaklik, word kortliks bespreek. 'n Nuwe apparaat vir hierdie doel word beskryf. Dit bestaan uit 'n tafel met aluminiumgeute, waarin klinknaels geplaas kan word, met verskillend gekleurde koppe, wat verskillende bedekking-abundansiewaardes voorstel. Met hierdie apparaat kan plantsosiologiese tabelle in twee stappe saamgestel word.

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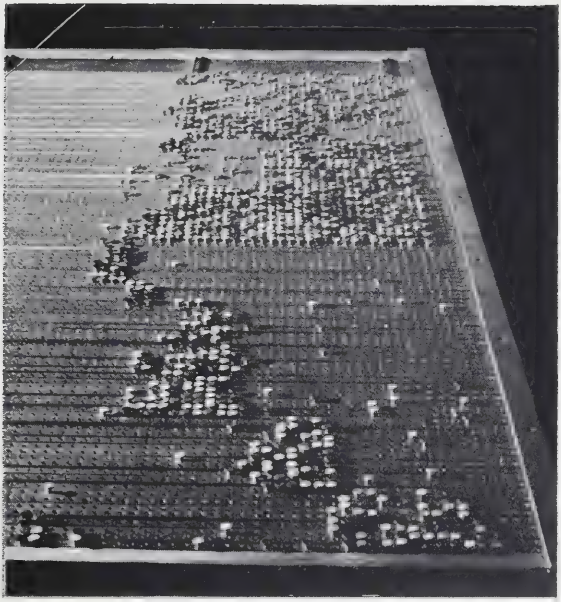

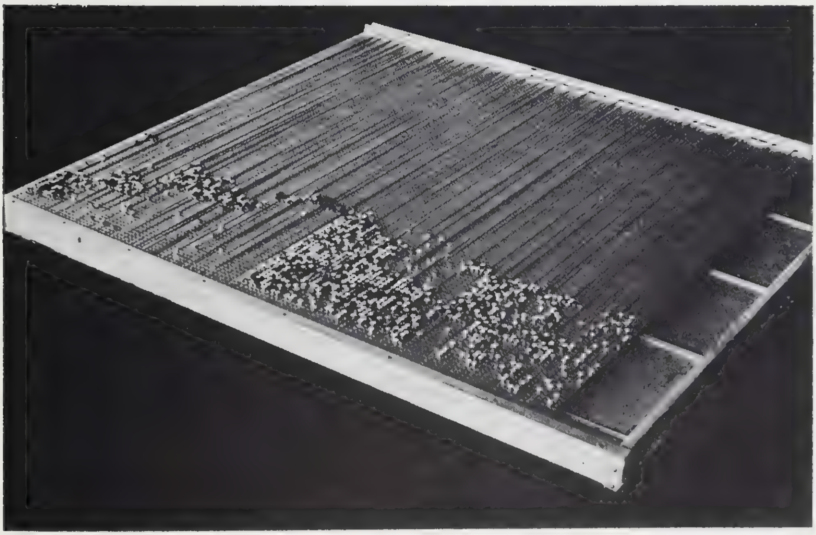

PLATE 1.—Two views of the apparatus designed for facilitating the manual tabulation of phytosociological data.

Bothalia, 10,4: 583–594.

Species-Area Relationship and Plot Size: with Some Examples from South African Vegetation

by

M. J. A. Werger*

Abstract

A short review is given of mainly recent literature dealing with the problem of minimal area and plot size for sampling vegetation.

A procedure to determine optimal plot size on the basis of the information content given by different plot sizes is demonstrated on 15 examples from eight different South African veld types.

Introduction

At the end of the last century in Europe and North America, the first attempts were made to consider vegetation ecologically. This new approach made it neccessary to define fundamental concepts on which the new science was to be based.

Soon a number of "schools" developed, differing in the concept of what vegetation basically is, and what possibilities there are to study and classify vegetation.

The development of the concepts and ideas of these various ecological schools are well documented by Whittaker (1962), McIntosh (1967) and Langford & Buell (1969). Very broadly one may divide the schools on bases of their approach: the individualistic and the classificatory. Schools of the individualistic approach regard variations in vegetation to be continual, although some pattern exists. This pattern can be investigated by sampling the vegetation. Schools of the classificatory approach regard vegetation as being composed of basic units of groups of plant species with sociological relations. These units are usually called communities, and can be classified in a system. Again, by sampling the vegetation, one can investigate these communities.

Most vegetation studies use a plot technique for sampling. A series of plots is layed out over the vegetation, according to a certain principle, and information within these plots is recorded. The plot technique, however, gave rise to a problem, namely, the size of the plot. It was reasoned that a pattern, or community, being composed of plant species, needs a certain area to manifest itself. This area was generally called the "minimal area". For adequate sampling, a plot must be large enough to cover the pattern or community to be investigated, and must, therefore, be at least the size of the "minimal area". On the other hand, in studying vegetation it is important, from the economic point of view, that no effort is wasted in collecting maximum information. Therefore, the ideal plot size will be the one nearest to the "minimal area", giving the most favourable balance between information obtained and effort expended.

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The problem, however, has proved to be in the definition of "minimal area".

The object of this paper is to show in a short review of relevant literature, largely after 1952 when Goodall published his extensive review, that the use of the concept of "minimal area" is impractical, mainly because it is impossible to define. It will be suggested that optimal plot size is a more useful concept, and that this can be expressed in terms of information required. It is clear that large plot sizes give more information but require much effort.

Some examples from South African vegetation types will demonstrate the applicability of this concept.

Species-Area Relationship

In the Braun-Blanquet school of phytosociology the determination of "minimal area" is usually based on the species-area curve. A series of nested quadrats is layed out in a homogeneous piece of vegetation and the increase in number of species in the successively enlarged area is recorded. The number of species is then graphically plotted against the area. In 1913, Braun-Blanquet (quoted in Goodall, 1952, and Hopkins, 1957) defined minimal area (Mindestausmass) as "the area above which no new species occur in the association". Later (1928, 1964) he modified this definition to "the area at which the species-area curve became more or less horizontal." Ellenberg (1956) gives the same definition: "Als Minimal-Areal der Gesellschaft gilt diejenige Flächengrosse, bei der die anfangs steil ansteigende Kurve in den fast waagerecht verlaufenden Ast umbiegt." Recently Tüxen (1970) reinterpreted this curve, regarding it as consisting of three phases: (a) a strongly curved phase; (b) a slanting straight line; and (c) a horizontal line. Minimal area is taken as the area at the point where the horizontal line starts.

It has often been pointed out (for example, Goodall, 1952; Cain & Castro, 1959; Van der Maarel, 1966; Daubenmire, 1968) that on the species area regression curve the point of inflexion depends on the relative scales of abscissa and ordinate axes. Cain & Castro (1959) showed that, depending on the ratio of these axes, they could find three different minimal areas for an American grassland association. They then tried to develop a more accurate and independent method to determine the point of inflexion. A tangent to the curve was constructed, parallel to a line through zero and a point (x, y), where x is 10% of the ultimate area that is surveyed, and y is 10% of the number of species for that area. The tangent "point" gives then the minimal area. This type of method has the great disadvantage, however, as pointed out by Goodall (1952), that the resulting minimal area depends closely on the size of the largest area that is surveyed—the larger this area, the larger the minimal area.

Du Rietz *et al.* (1920) (quoted in Goodall, 1952; Hopkins, 1957) and later again Du Rietz (1954), defined minimal area as the area above which there was no increase in constant species, constant species being those species of a community which have a percentage frequency greater than 90% on an area of sufficient size, that is, above the minimal area. They pointed out that there was a step in the constancy-area curve above which only extremely large areas would add new constant species. Other Scandinavian ecologists, like Nordhagen (1923) and Kylin (1926), doubted this. Nordhagen (1923) argued that the definition of minimal area must be of a practical kind and should be the area that includes all the important constant species, particularly the dominant ones.

In his analysis of twelve British plant communities, Hopkins (1955, 1957) came to the conclusion that neither a break in the species-area curves, in the sense of the Braun-Blanquet school, nor a step in the constancy-area curves in the sense of the Uppsala school, can be shown with enough evidence, and thus that a minimal area cannot objectively be defined on these bases. He introduced (Hopkins, 1955) the term "characteristic area", which can objectively be defined as $\frac{\alpha}{N}$, [where α is the index of diversity, and N the number of individuals ("plant units") on the sample area ("unit area")], but whose ecological meaning is not clear.

Poore (1964) constructed species-area curves for a tropical rainforest in Malaysia and found "little sign of flattening out at large areas." Later (Poore, 1968) he constructed species-area curves from the same data for a number of constant species and for tree species represented by more than ten and twenty trees. Apart from the curve for more then ten trees, which continues to rise, all these curves flattened at about 4 ha. Poore concluded that "if it is considered adequate to define forest types on constant species of large trees, sample areas amounting to between 2 and 5 ha should be large enough."

Van der Maarel (1966) concluded from a detailed study that minimal area cannot satisfactorily be defined as an absolute intrinsic character of the vegetation and, therefore, must be interpreted "pragmatically" as the minimal size of area that must be analysed to get a representative view of a vegetation. The term "representative" is not further defined. He based his practical definition then on frequent species (Van der Maarel, 1966; 1970).

Other definitions by investigators of the Braun-Blanquet school are given by Meyer Drees (1954), who distinguished qualitative and quantitative minimal area for applied survey in tropical rainforests. For qualitative minimal area practically all plant species are present, whereas in the quantitative sense all timber species reach such dimensions that it can serve as a basis for timber estimations. Beeftink (quoted in Van der Maarel, 1966) modified the concept of quantitative minimal area, as the area where all the species present get a rating on a combined abundance-dominance scale that is characteristic of the particular vegetation. Calléja (1962) studied a *Brachypodietum*, relating the increase in the number of species per increase of area $\left(\frac{\triangle y}{\triangle x}\right)$ to the surface area. He thus obtained hyperbolic curves whose parameters he considered characteristic of the particular vegetation. With this method, it is possible to determine objectively and practically a minimal sample size, but even then only after certain conventions have been adopted, for example, the choice of the system of co-ordinates to be used (Segal, 1969). Calléja found that a community does not have a strict floristic minimal area. Thus methods of studying minimal area based on species number are inadequate, or subjective, and that apart from floristics the structure of the vegetation should also be taken into account (Calléja, 1962). Gounot & Calléja (1962) suggested the use of co-efficient of similarity ($P = \frac{c}{a + b} \times 100$, in which a and b are the number of species in stand A and B respectively, and c is the number of species common to A and B), to define the minimal area, this being the area where the average co-efficient between four samples of the same size is significantly higher than a given value. Again one has to agree on the "given value". Segal (1969) pointed out the importance of taking into account the structure of the vegetation in defining the

minimal area. He distinguished qualitative minimal area, as the area, which even after a progressive increase, at most yields a relatively small increase in the number of species, and representative minimal area, as the smallest area that provides sufficient space for a combination of habitat factors to develop its characteristic vegetation composition and structure both in a qualitative and in a quantitative sense. He added that the practical difficulty of defining representative minimal area is to quantify it and that its estimation is much more subjective than is the case with the qualitative minimal area.

All these definitions, however, do not result in an objective method to determine minimal area. The pragmatic, rather than statistically determined, definitions are based on the fact that an association or community must be well known in its species and structure, before minimal area can be determined. Especially in areas where the vegetation has not yet been described in associations, these concepts of minimal area cannot serve as the basis for determining the optimal plot size.

Arrhenius (1920) (quoted in Gleason, 1922, 1925; Goodall, 1952; Van der Maarel, 1966) was the first worker, who presented a mathematical expression for the relations between number of species and area:

$$\frac{\text{size of area 1}}{\text{size of area 2}} = \left(\frac{\text{number of species in 1}}{\text{number of species in 2}}\right)^{n},$$

where n is a constant.

Gleason (1922, 1925) showed that this formula does not give a true picture of the relationships, especially in large areas where the number of species to be expected is much too high. Gleason (1925) presented then the formula:

$$\frac{\log B - \log A}{\log C - \log A} = \frac{b - a}{c - a},$$

where A and B are representative parts of area C, and a, b and c are the number of species on these areas respectively. This formula can also be written as:

$$y = a + b \log_e x,$$

where y is the number of species to be expected on area x, and a and b are constants (Goodall, 1952). Pidgeon & Ashby (1940) empirically derived a similar equation.

Fisher (Fisher *et al.*, 1943) derived from biological data, which he compared with the logarithmic series, the equation:

$$S = \alpha \log_e \left(1 + \frac{N}{\alpha}\right),$$

where S is the number of species observed, N the number of individuals and α a constant. Except for small areas, this curve fitted well the one produced by Gleason's (1925) equation, as was shown by Williams (1943). Williams (1943, 1944, 1947 a, b, 1950) called α the index of diversity, and he and others (for example, Von Broembsen, 1966) showed that this and similar formulae, and others, derived from this logarithmic series, fit well a wide variety of natural biological situations. Kilburn (1966) presented another formula for species-area relationships:

$$y = kx^z$$

where y is the number of species in area x, and k and z are constants. The value of k is taken as the number of species in one square metre, thus it should reflect species size, whereas z reflects the species richness of the community. Only on small areas, up to circa 900 m^2, does this formula fit the observed data.

Without defining the term minimal area, Goodall (1952) pointed out that the size of the minimal area will be smaller when using rectangular plots, than when one uses square or circular plots to survey a vegetation. This is because the sampling variance is usually less between narrow rectangles than between squares or circles of the same area. In a later paper Goodall (1954) argued that if the minimal area is not purely arbitrary, and since the idea of minimal area implies that one is sampling vegetation homogeneous in some sense, it must be reasonable and possible to base it on the concept of homogeneity. Thus he defined minimal area as the smallest sample area for which the expected differences in composition between replicates are independent of their distances apart. Tests done on a very uniform salt marsh vegetation in South-east Australia and on a semi-desert mallee scrub suggested that a minimal area does not exist, neither for single species, nor for a complete community.

In 1961 Goodall published a paper on pattern and minimal area, defining the latter as the smallest sample for which, for all species, the variation between replicate samples is independent of the distance between them. In this way no minimal area could be determined for mallee scrub in Australia and an Uganda rainforest.

In 1963 after some further studies in Western Australia, he mentioned, however, that it must be admitted that it is possible to find areas of vegetation which may satisfactorily be regarded as homogeneous even by a fairly vigorous test, and that in such areas a minimal area can be identified by appropriate techniques, such as analysis of variance at different spacings. Grid analysis failed to reveal any significant differences in variance at spacings greater than the average diameter of the dominant individuals.

English workers on statistical ecology studied the interrelated problems of pattern, homogeneity and minimal area in vegetation and concluded that there is "no objective significance for the idea of minimal area" (see Greig-Smith *et al.*, 1963; Greig-Smith, 1964; Kershaw, 1964).

We may conclude that an objective definition of minimal area seems impossible.

Optimal Plot Size

The optimal plot size to be used in sampling vegetation for phytosociological studies will be one giving the most favourable balance between information obtained and effort expended, as has already been pointed out. This suggests a pragmatic approach.

The regression equations of Gleason (1925) and Fisher (Fisher *et al.*, 1943) based on the logarithmic series, are generally regarded as best fitting the observed data (see Goodall, 1952; Hopkins, 1955; Dahl, 1957; Von Broembsen, 1962). The ratio of increase of information (here the increase of species per area) to increase of time needed to survey that area, was used by Scheepers (1968) to determine the most efficient plot size in a survey of the Highveld. The amount of time necessary to sample a plot is not an intrinsic character of the vegetation, however, and will depend on a number of factors. It will vary from observer to observer and from day to day, due to factors such as wind, rain, temperature and topography. Time measurement is, therefore, rejected here as a means for determining plot size.

In 1943 Williams plotted the number of species against the size of the area in which they occurred, both on a logarithmic scale, for areas from as small as 1 cm^2 up to the total landsurface of the earth using check lists and floras. He found that up to an area of circa one hectare the curve "follows the expected increase in species due to

increase in size of sample within a uniform population, or within a single ecological association. In other words, neither the climate nor the rest of the environment changes very rapidly on an average," within an area of this size. "As soon as we pass beyond this limit we begin to include new ecological conditions in our sample, with the result that the number of species will increase more rapidly than would be expected if the population sampled remained uniform."

Thus on the average an uniform population or community can manifest itself within an area of about one hectare and this area can thus be regarded as giving the typical species and structure of the community.

It would be very uneconomic to sample vegetation by means of plots of one hectare*, apart from the fact that in most cases it is difficult to find a reasonably homogeneous area of that size. With the regression equation:

$$y = a + b \log_e x$$

(Gleason, 1925; Goodall, 1952), where a and b will be calculated from observed data, the expected number of species in one hectare of the sampled vegetation can be calculated. Regarding number of species as amount of information, the 1 ha value can be taken as the 100% level of information. Arbitrarily and individually one can then decide, what percentage of information one requires per plot, depending, for example, on the scale of the survey, and so calculate the required plot size.

Some Examples from South African Vegetation

Fifteen samples were taken in eight South African Veld Types (Acocks, 1953) in order to test whether this procedure helps to determine optimal plot size. Twelve samples were taken in concentric circles with successive increase in radius (0,5; 1; 2; 3; 4; 6; 8; 12; 16; 20 m) i.e. the plot sizes varied between 0,8 m² and 1 256 m². Three samples in Fynbos vegetation were taken with rectangular nested quadrats of respectively 1; 2; 4; 8; 16; 32; 64; 128 and 256 m². Care was taken that the plots covered vegetation where the physiographic features and the vegetation structure were as homogeneous as possible. The importance of ecological homogeneity in this type of studies was emphasized by Dahl (1957). Every time the increase in number of species of permanently recognizable plants was noted. The samples were spread as follows:

Sample 1.—Riverine woodland; along Orange River at Goedemoed. Total cover estimated at 95%; tree layer up to 8 m, shrub layer up to 4 m, undergrowth up to 0,30 m.

Sample 2.—*Themeda—Festuca* Alpine Veld (Veld Type 58); in dense grassland about 16 km from Jouberts Pass near Lady Grey. Total cover estimated at 95%; soil loamy; very gentle slope (±3°); aspect SSW; one stratum up to 0,40 m.

Sample 3.—Dry *Cymbopogon—Themeda* Veld (50); in grassland near Morgenzon, between Lady Grey and Aliwal North. Total cover estimated at 40%; soil sandy; gentle slope (±5°); aspect SSW; *Elyonurus argenteus*, *Cymbopogon plurinodus*, *Themeda triandra* and other grasses dominant.

Sample 4.—False Arid Karoo (35); in open dwarfscrub near Kraankuil. Soil loamy sand; on plain. One stratum up to 0,50 m; *Pentzia incana* dominant.

Sample 5.—Central Upper Karoo (27); open dwarf scrub near Houtkraal north of De Aar. On calcrete rich plain. One stratum up to 0,45 m; *Pentzia incana* dominant.

* In tropical rainforest one could use plots larger than one hectare, which are then usually sampled by means of subplots. The problem still remains to determine the optimal size of the subplot.

Sample 6.—False Upper Karoo (36); in open dwarf scrub about 24 km from Norvals pont on way to Bethulie. Total cover estimated at 25%; dwarf shrub layer up to 0,40 m; layer of annuals, rosette plants, etc., up to 0,06 m; *Chrysocoma tenuifolia* dominant.

Sample 7.—False Upper Karoo (36); in open dwarf scrub about 13 km West of Bethulie. Total cover estimated at 60%; dwarf shrub layer up to 0,40 m; layer of annuals, rosettes, etc. up to 0,10 m; *Chrysocoma tenuifolia* dominant.

Sample 8.—False Upper Karoo (36); in open shrub and dwarf shrub vegetation at Tussen die Riviere near Bethulie. Total cover estimated at 30%; on dolerite; slope 15°; aspect SSE; dwarf shrub and grass stratum up to 0,30 m; shrub stratum up to 2,50 m; tree ±6 m. *Chrysocoma tenuifolia, Rhus ciliata* and *Rhus erosa* dominant.

Sample 9.—False Upper Karoo (36); in open scrub between Petrusville and Colesberg. Total cover estimated at 65%; on fine-grained sandstone and mudstone; slope 25°; aspect WSW; dwarf shrub and grass stratum up to 0,90 m; shrub stratum up to 4 m. *Rhus undulata* and *Euclea crispa* dominant.

Sample 10.—False Orange River Broken Veld (40); in open dwarf shrub vegetation near old road bridge across Orange River at Hopetown. Total cover estimated at 35%; on andesitic lava; slope 14°; aspect ESE; dwarf shrub and grass layer up to 0,40 m; very sparse shrub layer up to 2,5 m; *Chrysocoma tenuifolia* dominant.

Sample 11.—False Orange River Broken Veld (40); in open scrub-dwarf scrub between Hopetown and Douglas. Total cover estimated at 30%; on andesitic lava; on plain; dwarf shrub and grass layer up to 0,50 m; shrub and low tree layer up to 3 m. *Acacia mellifera* subsp. *detinens* and *Rhigozum trichotomum* dominant.

Sample 12.—Orange River Broken Veld (32); in open scrub-dwarf scrub, about 32 km from Douglas on way to Prieska. On andesitic lava with slight sand cover; on plain; dwarf shrub and grass layer up to 0,50 m; shrub layer up to 4 m. *Acacia mellifera* subsp. *detinens* and *Phaeoptilum spinosum* dominant.

Sample 13.—Fynbos (69); in dense *Protea neriifolia—Protea repens* scrub at Jonkershoek near Stellenbosch. Total cover estimated at 100%; on Table Mountain sandstone; slope 24°; aspect E; undergrowth up to 0,50 m; shrub layer up to 3 m.

Sample 14.—Fynbos (69); in *Protea arborea* pseudo-savannah at Jonkershoek near Stellenbosch. Total cover estimated at 95%. on Table Mountain sandstone; slope 36°; aspect N; undergrowth up to 0,60 m; tree layer up to 4 m.

Sample 15.—Fynbos (69); in dense Restionaceous vegetation at Jonkershoek near Stellenbosch. Total cover estimated at 95%; on granite; slope 32°; aspect SE; one vegetation layer up to 0,60 m with isolated emergents up to 2 m.

Table 1 shows the observed numbers of species of each plot at different plot sizes, the calculated constants a and b of the expression $y = a + b \log_e x$, and the expected number of species in 1 ha of the population. Calculated values for number of species fitted the observed values closely for the different plot sizes, indicating that reasonably homogeneous populations were sampled.

TABLE 1

Sample	Veldtype	Number of species at m^2										a	b	Expected number of species in 1 ha
		0,8	3,1	12,6	28,3	50,3	113,1	201,1	452,4	804,3	1256,6			
1	RW	4	7	10	15	17	18	19	21	—	—	6,2709	2,3902	28,3
2	58	12	15	17	26	28	30	32	34	—	—	14,1177	3,1849	43,5
3	50	14	22	26	31	33	37	42	46	53	—	18,2998	4,2341	57,3
4	35	6	8	14	16	18	24	30	33	35	38	6,3802	4,0277	43,5
5	27	3	5	8	10	13	16	17	21	25	26	3,3100	2,8235	29,3
6	36	9	13	15	17	20	21	24	29	37	44*	8,6576	3,6086	41,9
7	36	12	18	24	26	28	32	37	43	51	55	13,4841	4,8669	58,3
8	36	5	6	17	26	31	43	47	59	61	67	4,8735	7,9757	78,3
9	36	1	2	8	14	21	22	24	31	33	35	1,8187	4,3998	42,3
10	40	10	20	25	31	35	40	41	52	57	61	14,0146	5,9030	68,4
11	40	5	13	15	18	24	25	27	33	38	38	8,1385	3,9365	44,4
12	32	5	7	16	22	28	35	45	49	51	57	5,4999	6,6196	66,5

Sample	Veldtype	Number of species at m^2										a	b	Expected number of species in 1 ha
		1	2	4	8	16	32	64	128	256	—			
13	69	13	16	20	23	25	30	32	40	42	—	12,1778	5,2658	60,7
14	69	8	13	16	20	23	28	36	43	56	—	4,9999	7,9348	78,1
15	69	15	21	32	39	46	55	61	69	—	—	15,0000	11,2323	118,5

* This value was observed at r = 22 m, area 1520,5 m^2.

Taking the calculated number of species in 1 ha of the population as the 100% level of information, the plot sizes belonging to respectively the 40%, 50%, 55%, 60% and 70% levels of information were calculated. The results are shown in Table 2.

TABLE 2

Sample	Veldtype	Plot size in m² for % of ha-information				
		40%	50%	55%	60%	70%
1	RW	8,3	26,9	48,6	99,0	287
2	58	2,8	10,9	21,6	42,6	167
3	50	3,0	11,5	22,7	44,6	173
4	35	15,4	45,3	77,7	133,0	392
5	27	19,7	55,6	93,5	157,0	444
6	36	9,4	30,1	53,8	96,2	307
7	36	7,6	25,0	45,5	82,9	274
8	36	27,6	73,7	120,0	197,0	525
9	36	31,0	81,3	132,0	212,0	557
10	40	9,6	30,5	54,4	97,1	309
11	40	11,5	35,6	62,5	110,0	339
12	32	24,2	66,0	109,0	181,0	492
13	69	9,9	31,4	56,0	99,6	315
14	69	27,3	73,0	119,0	195,0	522
15	69	17,8	51,3	86,9	147,0	423

Comparing the two grassland samples from the *Themeda—Festuca* Alpine Veld (sample 2) and the dry *Cymbopogon—Themeda Veld* (sample 3) with the two dwarf scrub samples from the False Upper Karoo (samples 6 and 7) at the 40% level, it is necessary in karoid dwarf scrub to have a plot of about three times that in grassland in order to get the same amount of information. At the 60% level this value has become about two times. The same features are shown by comparing the two dwarf scrub False Upper Karoo samples (6 and 7) with the two open tall scrub and tree amples from the same Veld Type (8 and 9).

These differences are probably mainly due to the structure of the vegetation types. In a tall scrub and tree vegetation a number of plants have larger dimensions than in a dwarf scrub vegetation, thus the average plant interspacing is necessarily larger. The same applies to differences between dwarf scrub and grass vegetation types, although here the Karoo dwarf scrub vegetation is also usually more open than the Highveld grasslands.

Similar results were shown when the procedure was tested on a set of nested quadrats from 1 to 1 024 m², taken by Mr. J. C. Scheepers in Transitional *Cymbopogon—Themeda* Veld (49) near Kroonstad in an overgrazed, trampled, harvester termite infested, patchily denuded grassland. The number of species expected on one hectare of this grassland (52,7) compares well with the values of the other grasslands (samples 2 and 3; Table 1). Much larger plot sizes are necessary for this grassland than for the two others, however, to get a similar percentage of information (for 40% of ha-information 24,7 m², for 50% 67,3 m², for 55% 110,1 m²). These results show, that although the pattern in the grassland is similar to other grasslands, the structure is much coarser here, and one should sample it with much larger plots due to the patchily denuded veld.

The importance of the structural factor for plot size and minimal area have already been pointed out by Calléja (1962), Gounot & Calléja (1962), Segal (1969) and others.

Values for the False Arid Karoo and the Central Upper Karoo samples (4 and 5) are intermediate between the dwarf scrub (samples 6 and 7) and tall scrub and tree samples (samples 8 and 9) of the False Upper Karoo. Values for the False Orange River Broken Veld (10 and 11) compare well with the dwarf scrub of the False Upper Karoo (6 and 7) and values for the Orange River Broken Veld (12) with the tall scrub of the False Upper Karoo (8 and 9). Also, values for the open *Protea arborea* vegetation (Fynbos; sample 14) compare well with the tall scrub of the False Upper Karoo (8 and 9). Those for the *Protea neriifolia—Protea repens* scrub (sample 13) agree better with the dwarf scrub values from the False Upper Karoo (6 and 7), whereas the values for the Restionaceous vegetation (sample 15) compare with those of the False Arid Karoo (4) and Central Upper Karoo (5).

Of course, structure of the vegetation is not the only important factor. Floristic richness is also important. The sample from the riverine woodland (sample 1) shows values comparable with those of dwarf scrub False Upper Karoo (6 and 7) vegetation, although its structure is much coarser than these. This is probably due to the floristic poorness of the riverine woodland. On a rather small area most of the species are already present, and very few new ones appear on larger areas.

The structure of the vegetation of sample 15 is comparable with those of the grasslands (2 and 3). Still, in sample 15 a much larger plot size, similar to the False Arid and Central Upper Karoo, is needed to get an equal percentage of information. The floristic richness of the Restionaceous vegetation can be regarded as the main factor for this phenomenon.

Although this approach does not give a specific value for an optimal plot size for a certain type of vegetation, it allows one to form an idea of the percentage information obtained with different plot sizes. One can then decide arbitrarily what increase in information is worth the extra effort needed to sample a larger plot.

Arbitrarily, the author has regarded the optimum plot size as between 50% and 55% of the hectare-information for a phytosociological survey of the Orange River Valley.

If one reckons that an area of one hectare is insufficient for a certain community to manifest itself, one can calculate in the same way the expected number of species for any size area that is regarded as sufficient. The same procedure can then be followed for determining the optimal plot size.

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Bothalia, 10, 4: 595—598.

The Current Status of Mistbelt Mixed Podocarpus Forest in Natal

by

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Abstract

The known distribution and history of Mistbelt Mixed *Podocarpus* Forest in Natal, and its utilization and destruction are discussed. It is suggested that there may be a general drying of the forest climate, which is supported by evidence from canopy tree growth and regeneration. That this generally drier period has contributed to the rapid rate of forest degradation is postulated, and the need for the immediate implementation of conservation measures to ensure the safety of a representative area of forest is stressed.

Definition and Distribution

Mistbelt Mixed *Podocarpus* Forest was the name given by Edwards (1967) in his survey of the vegetation of the Tugela Basin, for the climatic climax forest vegetation of the Natal Mistbelt. Previously this forest type had been variously called High Timber Forest (Fourcade, 1889), Yellow Wood Bush (Bews, 1912) and Temperate Forest (Pentz, 1945; Acocks, 1953). It generally occurs between about 3 500 ft (1 000 m) and 4 500 to 5 000 ft (1 300 to 1 500 m), on steep south-facing slopes. These slopes are subject to relatively frequent mist, particularly in summer, (hence the name 'mistbelt'), and the rainfall is good (at least 1 000 mm a year), so the region is relatively moist. Temperatures are equable, with low maxima (about 37°C), high minima (about —4°C), and an annual mean of about 16°C (Weather Bureau, 1954). Moderately severe frosts occur on level ground, but probably not on the steep slopes on which the forest is situated. Snow does occur occasionally, and the rare heavy falls can cause great mechanical damage (Moll, 1965).

As the name suggests, the most important tree species are, or were, *Podocarpus* spp. Many associated tree species occur, such as *Ptaeroxylon obliquum*, *Celtis africana*, *Calodendrum capense*, *Olea capensis*, *Cussonia chartacea*, *Cryptocarya myrtifolia*, *Prunus africanus*, *Xymalos monospora*, *Kiggelaria africana* and *Combretum kraussii*.

Mistbelt Mixed *Podocarpus* Forest represents one of a series of three montane forest types found in Natal. Montane *Podocarpus* Forest occurs at higher altitudes, it is physiognomically and structurally reduced, and floristically depauperate (Moll, 1965; Edwards, 1967), The Inland Sub-tropical Forest types (Acocks, 1953) occur at lower altitudes and further north, and have greater floristic affinity with the Tropical Forests.

In Natal, Mistbelt Mixed *Podocarpus* Forest occurs from Qudeni in the north, to the Ingeli and Impetyne Forests in the south (Fig. 1).

Utilization

We know from various historical accounts, summarized relatively recently by Rycroft (1942), Moll (1965) and Edwards (1967), that the Mistbelt Mixed *Podocarpus* Forests of Natal were intensively worked for timber until about 1940. The chief species cut were *Podocarpus* spp., *Ocotea bullata*, *Ptaeroxylon obliquum* and *Olea capensis*. In addition poles, laths and saplings were taken out by the thousand for hut-building timber by the Bantu. Exploitation was not limited to severe tree cutting, the results of which are still exhibited by the irregular forest canopy, but also to the utilisation of forest areas as winter grazing for cattle—a practice which has a definite detrimental effect on regeneration (Taylor, 1961, 1962). The practice of burning the grassland surrounding the forest, without due precaution for the protection of the forest margins, has also contributed to forest destruction.

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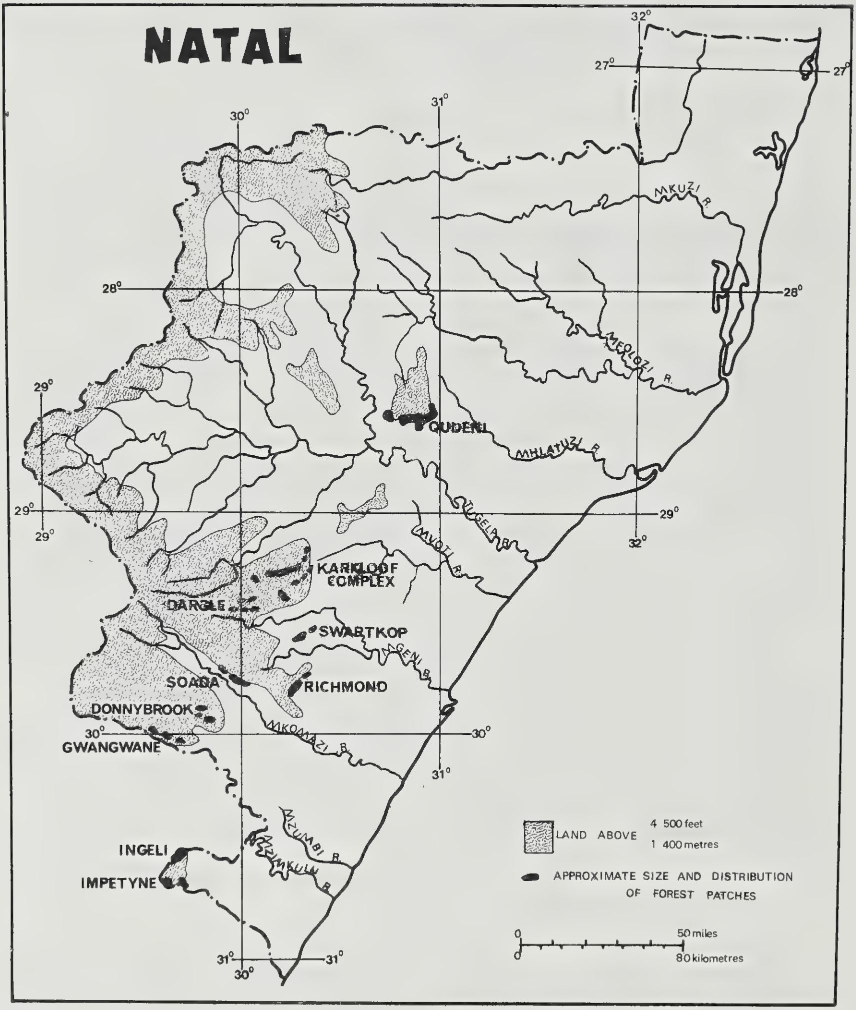

FIG. 1.—Map showing size and distribution of patches of Mistbelt Mixed **Podocarpus** Forest in Natal.

Today it is generally accepted that the major factor causing the reduction in size of our Mistbelt Mixed *Podocarpus* Forests is man. Taylor (1961) pleaded for the protection of the Karkloof Forest, which covered an estimated 80 000 acres in 1880 (Fourcade, 1889) and had greatly diminished to an estimated 15 000 to 20 000 acres by the early 1940's (Rycroft, 1944). Rycroft suggests that even if the 1880 estimate was high, it does mean that there might have been as much as 80% reduction of forest area in only 60 years, the chief factors causing this reduction being fire and over-exploitation. Taylor (1963) in a report on the Nxamalala Forest states that this forest, which was about 8 000 acres in area in 1880, had been reduced to a mere 1 500 acres 70 years later.

Observations on Canopy Tree Growth and Regeneration

In 1929 the resident forester at Xumeni Forest, near Donnybrook, laid out a line through the forest and on it recorded the circumference at breast height of all trees in 40 one chain square, systematically placed plots. In 1966, 37 years later, the same trees were re-measured (Moll & Woods, 1971). The results showed that the mean increment rate was very slow, 0,201 $\pm$0,05 (n$\pm$160) inches (5,10 $=$0,127 mm) in circumference per year. Common trees at Xumeni are *Podocarpus henkelii*, *Kiggelaria africana*, *Xymalos monospora*, *Podocarpus falcatus* and *Fagara davyi*. Of these species, *F. davyi*, *P. falcatus* and *K. africana* grew the fastest.

Moll & Haigh (1966) wrote of Xumeni that, "regeneration was poor, and it would appear that, under natural conditions, regeneration is not sufficient to maintain the forest". Xumeni Forest has been protected by the Department of Forestry since 1910.

In 1967/1968 Moll (in preparation) collected density data of all woody plants from twelve 40 $\times$ 40 m stands in the Karkloof Forest. The data indicated that the species regenerating were not those species that are presently important in the canopy. Common canopy trees in the Karkloof at present are, *Xymalos monospora*, *Podocarpus latifolius*, *Celtis africana*, *Calodendrum capense*, *Fagara davyi*, *Kiggelaria africana*, *Podocarpus falcatus* and *Ptaeroxylon obliquum*. Canopy tree species most common as young trees are *Ptaeroxylon obliquum*, *Podocarpus latifolius*, *Olea capensis*, *Podocarpus falcatus*, *Vepris undulata* and *Celtis africana*, while canopy tree species most common as seedlings and young saplings are *V. undulata*, *P. obliquum*, *P. latifolius* and *C. africana*. This means that species such as *X. monospora*, *C. capense*, *F. davyi* and *K. africana* are not regenerating and in future years will be unimportant canopy trees.

Taylor (1961) observed that on Miss Morton's farm in the Karkloof there were many seedlings of *Celtis africana*, *Cussonia chartacea* and *Ptaeroxylon obliquum*. He also noted that where cattle grazed the forest the tree seedlings were unable to advance, and that the two species common at Morton's, *Podocarpus henkellii* and *Ocotea bullata*, were not regenerating.

Moll (1965) observed that regeneration in the Dargle forests was restricted to *Podocarpus falcatus*, *P. latifolius* and *Ptaeroxylon obliquum*.

The general conclusion which can be drawn from these observations is that the species regenerating are those capable of tolerating a drier climate. Added to this, in areas of forest which have been protected, such as Xumeni which has been protected for the last 60 years, regeneration is poor. Seedling density in the Karkloof of 48 *Vepris undulata*, 32 *Ptaeroxylon obliquum* and 16 *Podocarpus latifolius* per hectare, is not indicative of active regeneration, not when one compares this to seedling densities in actively regenerating forests on the coast, such as at Hlogwene (Moll, in preparation) where, for example, there are 131 *Olea woodiana* and 94 *Strychnos decussata* seedlings per hectare. In addition, seedlings of trees which prefer a cool moist environment, such as *Ocotea bullata* and *Podocarpus henkelii*, are extremely rare.

Factors Contributing to a Drier Forest Climate

Moreau (1966) states that in the last 18 000 years the temperatures in Africa have risen by 5°C. Stuckenberg (1969) quotes Van Zinderen Bakker (1963), who states, "It has often been said that changes in temperature of the magnitude of only 5°C are of minor importance in a tropical continent such as Africa. These changes have, however, been of very great significance........Little but consistent changes of this nature can have an enormous influence on the distribution of plants and animals." Stuckenberg also quotes Bailey (1960), who states that these temperature changes affect maritime climates most. The Mistbelt Forests in Natal are influenced to a considerable degree by weather from the Indian Ocean.

Accepting a rise in temperature of 5°C during the last 18 000 years means that evaporation alone would be greatly increased. The mountain biomes which were more extensive are now much reduced; the montane limit, according to Moreau (1966), was about 2 300 ft (700 m), and is now 5 000 ft (1 500 m). Acocks (1953) also suggests that forest and scrub forest has largely disappeared in Natal, and that the drier vegetation types of bushveld and grassveld have greatly increased (see Acocks's Maps 1 & 2).

In addition to climatic changes, natural fires, and more especially man-made fires, have become more numerous and these too have contributed to forest destruction; both directly and also indirectly, by increasing runoff. Furthermore, cattle grazing in the forests not only eat and trample the vegetation, but also open up the margins, allowing wind to penetrate beneath the canopy and fires to enter protective marginal vegetation.

Preservation Requirements

Referring again to Acocks (1953), we are warned that unless our vegetation is scientifically managed the drier vegetation types will expand further. If we are to preserve an example of Mistbelt Mixed *Podocarpus* Forest we will, therefore, have to manage it.* It has been shown by a few conservation minded farmers who live in the Karkloof and Dargle areas that indigenous trees, such as *Ocotea bullata* and *Podocarpus henkelii*, if planted and cared for, grow relatively rapidly. However, the first priority is to have a sufficiently large area of forest proclaimed as a Nature Reserve. Once this has been achieved active management must include tree planting, run-off retention and protection of the margin from fire. Also large grazing and browsing animals must be excluded from the forest. Such management would have to be linked to a scientific monitoring programme, designed to measure which management practices are most beneficial in insuring maximum forest development.

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* Only 0,8% of the total area of Acocks's (1953) "Temperate & Transitional Forest and Scrub Types" is conserved (Edwards, 1971).

Bothalia, 10, 4: 599–614

A Phytosociological Study of the Cape Fynbos and other Vegetation at Jonkershoek, Stellenbosch

by

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Abstract

The Braun-Blanquet phytosociological method was tested in the complex Fynbos vegetation of the South-western Cape Region of South Africa. In the Swartboschkloof Nature Reserve, Jonkershoek, the Fynbos, riverine scrub and forest vegetation was classified preliminarily into eight communities, which are described floristically and related to habitat. The results hold promise, and the possibilities of classifying the Cape Fynbos in a formal phytosociological system are discussed.

Introduction

The Braun-Blanquet phytosociological method commonly used in Europe has remained relatively unknown in Southern Africa. Possible reasons for this are language difficulties, the need for more general, rather than more detailed information on the vegetation, and the general non-acceptance of the method by English and American plant ecologists. For many years the only source of information in the English-speaking world was Fuller & Conard's (1932) authorised translation of Braun-Blanquet's first edition of *Pflanzensoziologie* (1928), a work that omitted certain important details of the phytosociological technique. More detailed German works of the phytosociological school were largely inaccessible (for example Ellenberg, 1956; Braun-Blanquet, 1951, 1964).

In recent years an English evaluation of the method was given by Poore (1955, 1956), although his main criticisms were shown by Moore (1962) to be largely unfounded. Becking (1957) reviewed the phytosociological school and its concepts, and Küchler (1967) translated the tabulation techniques from Ellenberg (1956).[1]

Originally, nearly all vegetation surveys undertaken in Southern Africa were on a physiognomic or on a non-formal descriptive basis, with the exception of Acocks (1953) who used his own floristic technique to construct a system of veld types. Recently, multivariate analysis and ordination techniques have been applied by a number of ecologists in the Republic of Southern Africa (see Killick, 1966–67). In the Portuguese territories physiognomic classifications were created, and in each unit one sample was taken. The species list from each sample was rated on the Braun-Blanquet scale of cover-abundance and sociability (e.g. Gomes Pedro & Grandvaux Barbosa, 1955). In Central Africa, Belgian ecologists, traditionally familiar with the Braun-Blanquet method, have set up a hierarchy of syntaxa for the Congolese rain forests (Lebrun & Gilbert, 1954).

In Southern Africa it has often been suggested that the flora is too rich to apply successfully a floristic technique. In the Cape Fynbos, particularly, such techniques were thought to be impracticable. Outside Southern Africa also, Donselaar (1965), in a classification of the Northern Surinam savannas, stated that to use successfully the Braun-Blanquet method the number of species must be moderate.

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[1]The percentage classes of Braun-Blanquet as listed in Table 10, p. 231, Küchler (1967) are not correctly reproduced, as they give the impression of being based purely on cover. In reality they are based on cover and abundance.

From systematically distributed quadrats used for an association analysis of the vegetation of the Cape of Good Hope Nature Reserve, Taylor (1969) also prepared a Braun-Blanquet synthesis table. Due to the rigid sampling technique, a number of quadrats had to be excluded from the table as they were located on community transitions and were not representative of more or less homogeneous stands of vegetation. Nevertheless, he obtained associations that were recognizable in the field. This stimulated the authors to undertake a survey according to the phytosociological techniques described by Braun-Blanquet (1964) and Ellenberg (1956), in order to test its usefulness in the floristically rich Fynbos vegetation. The area chosen was the Swartboschkloof–Sosyskloof Nature Reserve in the Jonkershoek valley near Stellenbosch, as the results could also be used for the International Biological Programme survey of conservation sites.

The Study Area

The Swartboschkloof–Sosyskloof Nature Reserve, 373 hectares in extent, lies in the Jonkershoek Forest Reserve in the Hottentot Holland Mountains some 15 km from Stellenbosch, at 34°00′S latitude and 18°57′E longitude. It was proclaimed a nature reserve in terms of the Forest Act in 1936, to conserve vegetation representative of the Jonkershoek valley.

The vegetation is chiefly Fynbos (Acocks 1953, veld type 69). It consists mainly of sclerophyllous scrub and dwarf scrub, in which amongst other, Restionaceae and Cyperaceae also play an important rôle. A dense scrub grows along the river banks, and upstream, where the valleys narrow, small patches of forest occur. Van der Merwe (1966) analyzed vegetation-site units in the Reserve.

Topography, Geology and Soils

The Reserve is a fan-shaped valley at between 285 m and 1 200 m altitude. The steep slopes average about 30°, ranging from about 5° to 50°. Aspect is largely northerly with only about 5 per cent of southerly facing slopes.

Porphyritic granite of the Pre-Cape System forms the undulating floor of the valley, but is often buried by sandstone talus fans from the medium-grained homogeneous sandstones of the Table Mountain Series. The sandstones are very resistant to erosion so that the valley is bounded by precipitous cliffs and knife-edge ridges. Continuous creep characterizes the talus on the slopes below the cliffs.

The valley was formed by a series of secondary faults, roughly at right angles to those which gave rise to the main Jonkershoek valley. Streams follow the courses of these faults. The jointed layers with a northerly tilt store a fair proportion of the precipitation which is released in conspicuous seepage steps.

Soils are generally poorly developed, rocky and acid, the granite soils being less acid than the sandstone. Those soils derived from granite are often over 1 m deep and more fertile than those from sandstone, which are coarse-textured, skeletal and rarely over 1 m deep. Mixtures of granite and sandstone debris give rise to intermediate soils. Humic and organic soils of varying depth (0,05–2 m) occur locally on wet sites.

Climate

Wicht *et al.* (1969), in describing the climate of the Jonkershoek valley in some detail, notes that "The climate is Etesian of the Mediterranean type,........with a dry summer and the average temperature of the warmest month below 22°C........" It conforms to Walter & Leith's (1960) Climate Type IV, and to Köppen's (1931) humid-mesothermal *Erica*-climate. Precipitation is usually associated with strong cyclonic winds from the north-west. In summer, strong anti-cyclonic winds from the south-east prevail. These are generally dry, but frequently deposit moisture at highe

altitudes. From a rain-gauge at the mouth of the Swartboschkloof valley the mean annual rainfall over 20 years is about 1 600 mm. Fifty per cent of this fell during the months May to August, and only 12 per cent from December to March, when the greatest moisture deficits occur. Snow falls rarely at higher altitudes.

History of anthropogenic influence

For millenia the Jonkershoek Valley was visited intermittently by Khoisan tribes, but they probably seldom settled there (Schapera, 1930; Seddon, 1966, 1967).

Colonists first settled in the Valley in the late 17th century, but the effects of their agricultural practices on Swartboschkloof was probably first evident after 1832, when the Reserve formed part of land transferred to a farmer living close by. The early farmers used these lands as grazing for sheep, goats and cattle, exploiting the forests for timber, the *Protea arborea* stands for firewood, and such shrubs as *Agathosma crenulata* for medicinal uses.

Early man probably had little effect upon the vegetation, but European colonization would have initiated rapid change. Veld-burning to improve grazing was fairly standard practice, and Swartboschkloof was probably burnt at 4–10 year intervals—more frequently than probably occurred naturally. Grazing would have been restricted largely to the lower slopes owing to the steep topography. The area does not appear to have been cultivated. Mammal populations diminished or disappeared as a result of hunting and the destruction of habitats in the surrounding lowlands.

The acquisition of Jonkershoek by the Department of Forestry in 1933 and proclamation of the Nature Reserve introduced radical changes in land-use. A policy of complete fire protection was adopted, and only recreation and non-destructive research were permitted in Swartboschkloof. The Reserve is surrounded by firebreaks, burnt in spring or autumn on a 4-year rotation. In spite of policy, the whole reserve burnt accidentally in December 1942 and February 1958. Two small fires also occurred during this period.

Methods

Gleason's (1925) regression equation, as reformulated by Goodall (1952), was applied to data from three sets of nested quadrats, 1 m^2 to 256 m^2 in size, to estimate the quadrat size-information ratio (Werger, 1970). On this basis a quadrat size of 100 m^2 was selected. The Braun-Blanquet method does not require uniform sized quadrats, but as many as possible were 100 m^2 for the sake of consistency. Only two quadrats (nos. 14 and 37) were taken at 50 m^2 to avoid obvious heterogeneity due to a sharp change in slope aspect and to a conspicuous vegetational difference. Quadrat nos. 42, 43 and 44 were 128 m^2, being a stage in a set of nested quadrats.

Altogether 44 quadrats were layed out at sites selected on the basis of visually assessed homogeneity of vegetation structure and habitat. Species in each quadrat were listed and rated on the Braun-Blanquet cover-abundance scale. Only permanently recognizable species were recorded, thus omitting annuals and most geophytes. Site features such as slope angle, aspect and altitude were measured, soil depth was estimated, and geological and geomorphological characteristics were noted.

The data were entered in a raw table and from this an association table was compiled (Tables 1 and 2), according to the prescribed methods. Tables 1 and 2 list character species for each community, together with those species with over 50 percent presence in a group of two, three or four related communities. The remaining species are grouped in a "tail" of the tables. Of this "tail", species occuring only once or twice and with low cover-abundances in the quadrats, are listed for convenience in the Appendix. Complete species-quadrat lists are considered important for Braun-Blanquet phytosociological work, because some of the species will assume greater importance when further data are acquired, and are necessary if current concepts of the communities are to be revised.

The communities are named after one or two faithful and conspicuous species, so that they are easily recognizable in the field.

To obtain complete pictures of the communities and their relationships, more data are needed, preferably from other areas. Only then will it be possible to decide with certainty whether some of the below mentioned species are true character species.

The Communities

Based on floristic composition we have distinguished five Fynbos, one riverine scrub and two forest communities.

Fynbos

The Fynbos communities usually consist of two or three layers: a graminoid and dwarf shrub layer, a shrub layer and, in some communities, a tall shrub or small tree layer (Table 1).

1. Protea arborea—Rhus angustifolia *Community*

This community consists of many of the more common Fynbos species. The vegetation usually consists of three layers: a tall shrub and small tree layer from 2–3 m high; a shrub layer 1–1,5 m high; and an undergrowth of sedges, grasses, restionaceous plants, other herbs and dwarf shrubs from about 0,10–0,60 m high. The middle layer usually has the highest cover, although sometimes the upper layer may dominate.

There are a number of possible character species, which are, however, not fully constant, like *Podalyria myrtillifolia*, *Euphorbia genistoides* and *Helichrysum zeyheri*. Constant but not strictly faithful character species appear to be *Diospyros glabra* and *Rhus angustifolia*. A number of species that clearly typify this community and the *Restio perplexus* Community are *Protea arborea* (which has its optimum in this community), *Psoralea obliqua*, *Watsonia pyramidata*, *Themeda triandra* and *Ursinia filiformis*.

The *Protea arborea—Rhus angustifolia* Community is found on relatively deep, detrital, sandy loam soils; slope varies, but aspect is generally between north and east. It is limited to lower altitudes (up to ca. 600 m) in Swartboschkloof.

2. Brunia nodiflora—Psoralea rotundifolia *Community*

This community generally has the usual three strata: a tall shrub and small tree layer (1,5–3 m), a shrub layer (0,60–1,20 m) and an herbaceous dwarf shrub undergrowth (0,10–0,60 m). High cover values are obtained, especially in the undergrowth, although sometimes they are high in the upper layer as well. The community has a number of good character species: *Brunia nodiflora*, *Psoralea rotundifolia*, *Helichrysum teretifolium*, *Corymbium scabrum*, *Danthonia lanata*, *Osteospermum tomentosum* and *Tetraria burmannii*. Abundant here, but common also to the *Thamnochortus gracilis-Hypodiscus aristatus* Community, is *Restio filiformis* (Table 1).

Species common to this community and the *Protea arborea—Rhus angustifolia* Community are *Anthospermum aethiopicum*, *Montinia caryophyllacea*, *Asparagus thunbergianus*, *Diosma hirsuta*, *Ficinia filiformis*, *Lichtensteinia lacera* and a number of other species.

The community occurs in a very distinct habitat, with generally steep slopes (16°–32°) and relatively deep detrital soils, with a definite south-eastern aspect. It occurs mainly at altitudes of 300–500 m.

3. Thamnochortus gracilis—Hypodiscus aristatus *Community*

The shrub layer (0,75–1,50 m high) is the most important stratum in this community. There is an undergrowth of about 0,20–0,50 m high, but the upper layer of ca. 2 m high tall shrubs and small trees if often wanting.

Relevé number	22	6	1	2	36	3	4	5	41	42	43	23	44	13	7	8	9	10	11	27	14	17	19	20	24	25	28	21	29	34	35	33	18	40	38	12
Total number of species	24	23	40	39	43	47	46	31	39	39	40	42	64	53	49	56	43	44	42	30	40	34	43	37	48	43	44	44	35	57	34	31	13	16	27	16
Altitude (m)	380	400	320	320	550	350	460	410	390	420	440	410	440	450	330	390	—	470	500	640	630	650	710	770	540	490	600	510	580	1150	900	940	700	390	550	350
Aspect	NE	N	NE	N	NW	NE	NE	N	N	E	N	N	SE	SE	E	E	E	E	E	W	SE	E	NE	NE	SW	S	W	E	NE	NE	N	NE	E	NE	NW	NE
Slope (°)	11	5	5	3	16	5	26	6	25	24	36	0	32	16	16	18	20	17	21	31	23	15	13	19	28	34	27	28	34	25	35	43	18	8	12	7
Geology (g = Granite; T = Table Mt. Sandstone)	T	gT	gT	gT	gT	gT	T	gT	T	gT	T	gT	g	gT	gT	gT	g	gT	g	T	T	T	T	T	T	T	T	gT	gT	T	T	T	T	gT	g	gT
Soil depth (m)	>1	±1	±1	±1	±1	±1	±1	±1	<.5	±1	<.7	>1	±1	±1	±1	±1	±1	±1	±1	±.5	<.1	<.5	±.3	<.3	±1	±.5	±.5	±1	±1	>.5	>.5	<.5	<.5	>1	>1	±1
Total cover (%)	98	98	50	95	98	95	80	98	90	100	95	100	95	80	95	85	80	75	85	80	45	55	85	65	70	80	70	80	85	65	85	80	98	95	95	98
Character species Prot. arb.-Rhus ang. Comm.																																				
Diospyros glabra (L.) de Winter	+	1	+	1	1	2	2	+	+	2	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhus angustifolia L.	.	1	.	+	+	+	+	1	.	.	+	1	.	.	r	.	.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Cassytha ciliolata Nees	.	+	.	2	.	1	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pteridium aquilinum (L.) Kuhn	.	1	.	3	2	.	.	3	.	.	.	r	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	3
Podalyria myrtillifolia Willd.	.	.	+	.	+	+	.	.	.	.	+	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	1	.	.	+	1
Euphorbia genistoides Berg.	.	.	+	+	.	+	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Helichrysum zeyheri (DC.) Less.	.	.	r	r	.	.	r	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2
Rhus tomentosa L.	.	.	.	r	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Character species Brun. nodifl.-Psor. rot. Comm.																																				
Psoralea rotundifolia L.f.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum teretifolium (L.) Sweet	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Corymbium scabrum L.f.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brunia nodiflora L.	.	.	.	.	+	.	.	.	.	+	.	.	r	.	1	+	1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Danthonia lanata Schrad.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	1	+	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Osteospermum tomentosum (L.f.) T. Norl.	.	.	.	.	.	.	.	.	.	.	.	.	r	2	.	+	.	2	3	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tetraria burmannii C.B. Cl.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	+	+	+	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Psoralea fruticans (L.) Druce	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Adenandra serpyllacea Bartl.	.	.	.	.	r	.	.	.	.	.	.	.	+	+	1	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Elytropappus glandulosus Less.	.	.	.	.	.	+	.	.	.	.	.	.	+	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hypodiscus willdenowia Mast.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	+	+	r	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Character species Thamn. grac.-Hypod. arist. Comm.																																				
Restio sieberi Kunth	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anthospermum ciliare L.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thamnochortus gracilis Mast.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	3	+	+	1	1	1	1	2	1	1	2	1	+	.	.	.	.
Staberoha cernua (L.f.) Dur. & Schinz.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	r	.	r	+	+	+	+	+	.	+	+	+	+	.	.	.	.	.	.
Prismatocarpus diffusus A. DC.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	+	1	1	1	+	+	.	+	.	.	.	.	.	.
Tetraria capillacea (Thunb.) C.B. Cl.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	+	1	1	2	+	.	.	.	.	.	.	.	.	.
Tetraria fasciata (Rottb.) C.B. Cl.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	r	.	+	.	.	.	.	.	.
Hypodiscus aristatus (Thunb.) Nees	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	r	2	1	+	+	1	1	+	.	.	.	.	.	.	.	.
Willdenowia sulcata Mast.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	1	1	1	.	.	.	.	.	.	.	.	.
Blaeria dumosa Wendl.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	2	1	+	+	2	.	.	.	.	.	.	.	.
Clutia polygonoides L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	1	.	1	.	.	.	.	.	.	.	.	.
Pentameris macrocalycina (Steud.) Schweick.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	+	1	+	1	+	.	.	+	1	.	.	.	.	.	.
Widdringtonia cupressoides (L.) Endl.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	+	+	+	+	+	+	.	r	+	.	.	.	.	.	.
Erica coccinea L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	+	+	.	.	.	.	.	+	.	.	.	.	.	.
Psoralea aculeata L.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	+	1	r	r	.	.	.	.	+	.	.	.	.	.	.
Elegia racemosa (Poir.) Pers.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	3	3	2	.	.	.	.	.	.	.	.	.
Cliffortia atrata H. Weim.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	+	.	.	.	.	.	.	.	.
Coleonema juniperinum Sond.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	1	2	r	.	.	.	.	.	.	.	.	.
Sympieza articulata (Thunb.) N.E. Br.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	+	r	+	1	+	.	.	.	.	.	.	.	.	.	.
Lobelia coronopifolia L.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	3	.	+	2	+	+	.	.	.	.	.	.	.	.	.	.	.
Nebelia paleacea Sweet	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Scyphogyne muscosa (Ait.) Druce	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	4	2	1	2	.	.	.	.	.	.	.	.	.	.
Character species Restio perpl. Comm.																																				
Cliffortia polygonifolia L.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	r	r	.	.	1	2	2	.	.	.	.
Euryops abrotanifolius (L.) DC.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.
Restio perplexus Kunth	.	.	.	.	+	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	+	.	.	.	.
Asparagus compactus Salter	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.
Venidium semipapposum DC.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.
Character species Berz. lan.-Osm. ast. Comm.																																				
Carpha glomerata Nees	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	1	1
Psoralea aphylla L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	+	+
Osmitopsis asteriscoides (L.) Cass.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	+	2	.
Berzelia lanuginosa Brongn.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	2	4
Elegia capensis (Burm.f.) Schelpe	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	3	.	.	2
Leucadendron salicifolium (Salisb.) Williams	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	3	.
Restio graminifolius Kunth	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	3	.	.
Cliffortia graminea L.f.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	3	.
Tetraria punctoria C.B. Cl.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.
Elegia thyrsifera Pers.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.
Leptocarpus paniculatus Pillans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
Species common to Prot. arb.-Rhus ang., Brun. nodifl.-Psor. rot., Thamno. grac.-Hypod. arist. and Restio perpl. Comms.																																				
Tetraria cuspidata (Rottb.) C.B. Cl.	+	.	+	+	.	+	+	.	+	r	+	.	2	+	+	+	+	+	1	1	+	1	+	+	+	+	+	.	+	+	+	.	.	.	.	.
Cymbopogon marginatus Stapf	1	.	2	2	1	1	+	1	+	+	2	.	+	+	1	1	2	+	.	+	.	.	+	.	+	.	+	+	+	+	2	+	.	+	.	.
Aristea thyrsiflora (Delar.) N.E. Br.	+	3	+	+	+	+	1	+	+	+	.	1	.	+	+	+	+	+	+	+	.	.	+	.	.	.	+	.	+	+	1	+	.	.	.	.
Erica hispidula L.	1	.	.	+	+	+	2	.	+	+	.	+	1	+	r	.	+	+	+	.	.	.	+	.	.	.	+	.	+	.	.	.	.	+	.	.
Clutia alaternoides L.	.	+	+	+	+	+	1	+	+	.	2	.	.	+	+	+	+	.	+	.	+	2	2	1	1	+	+	3	+	+	1	+	1	+	.	+
Stoebe plumosa (L.) Thunb.	+	+	r	3	+	.	2	3	.	.	+	+	+	.	+	+	+	.	.	.	+	.	+	+	.	.	.	+	.	+	4	4	.	.	.	.
Danthonia stricta Schrad.	2	.	1	2	+	1	2	1	.	1	2	+	.	.	+	.	.	.	.	+	+	.	+	.	+	+	.	+	.	.	2	2	.	1	.	.
Restio triticeus Rottb.	+	.	+	.	+	.	+	.	.	2	+	2	2	1	+	1	2	.	.	+	.	.	+	+	.	.	+	+	1	+	+	+	.	.	.	.
Pentaschistus colorata (Steud) Stapf.	+	.	.	+	.	.	+	.	1	.	.	.	1	+	.	.	1	+	.	3	+	.	.	.	1	+	2	1	1	1	.	1	.	.	.	.
Bobartia indica L.	.	.	.	.	+	.	+	+	1	1	.	+	1	1	1	+	+	+	+	+	+	.	+	1	+	.	1	1	2	+	.	.	.	.	.	.
Species common to Prot. arb.-Rhus ang., Brun nodifl.-Psor. rot. and Thamn. grac.-Hypod. arist. Comms.																																				
Leucadendron adscendens R. Br.	+	r	1	+	.	+	.	1	1	1	.	1	.	1	+	+	1	1	1	+	.	+	1	.	r	.	+	r	+	.	.	.	.	.	.	.
Tetraria bromoides (Lam.) Pfeiffer	+	+	.	.	.	.	+	+	+	1	.	r	1	+	+	1	1	1	+	+	.	+	+	.	r	1	+	+	+	.	.	.	.	.	.	.
Cliffortia ruscifolia L.	.	.	.	.	.	1	+	.	2	3	.	+	1	2	.	.	.	.	1	5	.	r	+	.	+	r	+	1	+	.	.	.	.	.	.	.
Erica globulifera Dulfer	+	3	.	1	.	+	1	.	+	3	.	+	1	.	.	+	.	4	+	+	+	.	.	+	+	.	+	r	.	r	.	.	.	.	.	.
Aristea capitata Ker.	.	.	+	.	+	.	.	+	+	.	1	+	.	.	.	.	+	+	.	.	.	.	.	+	+	.	+	.	.	.	.	.	.	.	1	.
Eremia totta (Thunb.) Don.	.	+	.	.	.	.	.	+	+	2	.	+	+	+	+	.	.	r	+	.	+	+	+	.	+	+	.	.	.	+	.	.	.	.	.	.
Erica nudiflora L.	+	.	.	.	.	.	+	.	.	+	+	+	+	+	+	.	+	+	+	1	.	.	+	+	+	r	1	r	+	.	.	.	.	.	.	.
Species common to Prot. arb.-Rhus ang. and Brun. nodifl.-Psor. rot. Comms.																																				
Anthospermum aethiopicum L.	.	+	+	1	+	2	+	+	1	1	2	1	+	+	+	+	1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Montinia caryophyllacea Thunb.	.	2	.	1	+	1	+	1	+	1	+	+	r	+	+	+	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Restio gaudichaudianus Kunth	.	+	2	.	2	2	1	.	1	3	3	1	3	+	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asparagus thunbergianus Schultf.	.	.	1	1	+	1	+	1	+	+	1	+	.	+	+	+	+	.	.	.	.	.	.	.	+	.	.	r	.	.	.	.	.	.	+	r
Diosma hirsuta L.	+	.	+	.	.	.	+	.	+	+	.	+	.	+	+	+	.	r	r	.	.	.	.	.	+	.	.	.	+	.	.	+	.	.	.	+
Protea neriifolia R. Br.	.	.	.	.	.	+	+	.	.	.	.	.	1	.	+	+	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Ficinia filiformis Schrad.	.	2	.	.	5	+	+	1	5	4	.	3	1	3	5	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Lichtensteinia lacera Ch. & Sch.	.	.	+	.	+	+	.	+	+	r	.	.	+	r	+	+	+	+	+	.	.	.	.	r	.	.	.	4	.	.	.	.	.	.	+	.
Rhus rosmarinifolia Vahl.	.	.	.	+	+	+	.	.	+	+	.	.	.	.	+	+	+	r	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Protea repens (L.) Linn.	.	+	+	1	+	+	.	+	+	+	+	.	.	r	+	+	+	r	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Berkheya armata (Vahl.) Druce	.	.	+	+	.	2	.	.	2	.	.	2	.	2	+	4	+	.	+	.	.	r	.	r	.	.	.	.	4	.	.	.	.	.	.	.
Pentaschistus curvifolia (Schrad.) Stapf.	+	.	.	.	+	+	.	.	+	1	+	+	+	+	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species common to Prot. arb.-Rhus ang. and Restio perpl. Comms.																																				
Protea arborea Houtt.	.	.	2	1	1	2	1	2	1	+	2	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	+	2	.	.	.	.
Watsonia pyramidata (Andr.) Stapf.	.	.	+	.	.	+	+	+	1	2	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	r	+	+	+	2	2	.	.	.	.
Themeda triandra Forsk.	.	.	1	+	2	1	.	.	+	.	1	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	+	.	.	.	.
Psoralea obliqua E. Mey.	.	+	1	+	+	+	.	+	+	r	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.
Ursinia filiformis Griessel.	+	.	+	+	.	.	+	.	.	.	+	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.
Species common to Brun. nodifl.-Psor. rot. and Thamn. grac.-Hypod. arist. Comms.																																				
Restio filiformis Poir.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	r	.	+	+	+	.	.	.	.	.	.	.	.
Tetraria ustulata (L.) C.B. Cl.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	+	1	+	3	2	.	+	.	+	r	+	+	+	.	1	.	.	.	.	.	.	.
Metalasia muricata (L.) Don.	.	.	.	.	+	r	.	.	.	.	.	.	1	+	.	1	r	+	.	r	1	+	+	+	+	+	2	.	+	.	.	.	.	.	.	.
Pentaschistus steudelii McClean	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	+	.	+	+	+	r	+	+	+	+	.	r	.	.	.	.	.	.
Penaea mucronata L.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	1	.	.	+	.	.	.	.	+	.	1	.	.	.	2	+	.	.	.	.	.	.
Ursinia crithmoides (Berg.) Poir.	.	.	.	.	.	.	.	.	+	.	.	.	1	.	2	1	.	.	.	.	r	.	.	+	.	r	.	.	r	+	+	.	.	.	.	.
Corymbium glabrum L.	.	.	1	.	.	.	.	.	.	.	.	.	r	.	r	+	+	r	r	.	+	.	+	.	+	+	+	.	1	+	.	.	.	.	.	.
Accompanying species																																				
Protea acaulis Thunb.	.	+	+	+	.	+	.	.	.	+	.	+	+	+	.	+	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Erica plukeneti L.	.	.	.	.	.	.	r	.	.	r	.	1	+	2	+	+	.	.	2	.	r	+	+	.	.	.	+	+	+	+	.	.	.	.	.	.
Haplocarpha lanata (Thunb.) Less.	.	.	.	.	.	.	.	.	.	r	.	+	+	.	r	+	.	.	+	.	.	.	.	.	r	.	+	.	.	+	+	.	.	.	.	.
Maytenus oleoides (Lam.) Loes.	.	.	.	+	.	1	+	1	+	+	.	2	+	.	1	1	+	.	.	.	.	.	.	.	.	+	+	.	.	+	+	.	.	.	.	.
Cliffortia cuneata Ait.	.	.	.	+	2	1	.	.	2	.	1	.	+	r	.	+	.	.	.	+	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Centella glabrata L.	.	.	+	.	+	+	.	.	.	.	.	.	r	.	.	+	.	+	.	.	+	.	.	.	.	.	.	.	2	.	.	1	r	.	.	.
Corymbium villosum Less.	.	.	+	.	+	+	.	.	+	+	.	.	+	.	.	.	.	r	.	.	.	.	.	.	.	.	+	+	+	.	.	3	.	.	.	.
Elegia juncea Linn.	.	.	.	.	.	.	1	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	+	.	.	.	.	.	.
Osmites hirsuta Less.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	r	.	.	.	.	+	+	.	.	.	+	r	1	.	+	r	.	.	.	.	.
Agathelpis dubia (L.) Hutch.	.	.	.	.	r	.	.	.	.	.	.	.	.	r	.	+	.	+	.	r	r	.	.	.	+	+	+	.	+	+	+	.	.	.	.	.
Stoebe spiralis Less.	.	.	.	.	+	.	+	.	.	r	.	.	.	r	.	+	.	.	.	.	.	r	.	.	+	.	.	.	.	r	+	.	.	.	.	.
Scabiosa columbaria L.	.	+	+	.	+	+	+	.	.	r	.	+	.	+	.	r	.	+	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.
Caesia eckloniana Roem. & Schult.	.	r	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	r	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Gnidia inconspicua Meisn.	+	r	.	.	.	.	.	.	.	r	+	.	.	r	+	.	+	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Erica articularis L.	+	1	+	.	+	.	.	.	.	.	+	+	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phylica spicata L.f.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	r	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Hypodiscus albo-aristatus (Nees) Mast.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leucadendron spissifolium (Knight) Williams	.	.	.	.	.	.	1	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	+	.	1	+	+	1	1	.	.	.	.	.	.
Ficinia bracteata Boeck.	.	.	+	.	+	+	.	.	.	.	+	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.
Ficinia deustra (Berg.) Levyns	.	.	.	.	+	+	.	.	.	r	.	.	.	+	.	+	.	+	.	+	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.
Ehrharta ramosa Thunb.	.	.	+	r	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	+	r	+	+	+	+	.	.	.	.
Thamnochortus fruticosus Berg.	+	.	+	.	.	.	.	.	+	.	+	.	+	.	+	.	.	.	.	+	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.
Schizaea pectinata (L.) Sw.	.	.	+	.	+	+	.	.	+	+	.	.	+	.	+	.	.	.	.	+	.	r	.	r	.	+	+	.	.	.	.	.	.	.	.	.
Gerbera crocea (L.) O. Kuntze	.	r	.	.	.	+	.	.	r	.	.	.	r	.	.	.	.	.	.	.	.	.	+	.	r	.	r	.	.	.	.	.	.	.	.	.
Agathosma juniperifolia Bartl.	.	.	.	+	.	.	.	.	.	.	.	+	r	.	+	.	.	.	r	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Restio cuspidatus Thunb.	.	r	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.
Erica curvirostris Salisb.	.	.	.	+	.	.	.	.	.	.	.	+	.	r	.	.	r	.	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Ehrharta bulbosa Sm.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Cannamois virgata (Rottb.) Steud.	.	.	.	.	+	+	.	+	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	+	2	+	.	.	r	.	.	.	.	+	+
Stoebe cinerea (L.) Thunb.	.	.	.	.	1	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Erica calycina L.	.	.	.	+	.	.	r	.	.	.	.	.	.	+	.	.	1	+	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.
Helichrysum odoratissimum (L.) Sweet.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	.	.	.	+	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.
Muraltia heisteria (L.) DC.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	r	+	.	r	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Pellaea viridis (Forsk.) Prantl	.	.	.	.	+	.	.	.	.	.	.	.	r	.	.	r	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Phylica pubescens Ait.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Muraltia alopecuroides (L.) DC.	.	.	.	.	1	.	.	3	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	r	.	.	.
Helichrysum crispum (L.) D. Don.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	r	.	.	+	.	.	.	1	.	.	.
Helichrysum cymosum (L.) D. Don.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.
Mohria caffrorum Desv.	.	.	.	+	.	.	+	.	.	+	+	.	r	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Aspalathus laricifolius Berg.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ehrharta dura Nees ex Trin.	.	.	1	.	.	r	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Argyrolobium lunatis (L.) Druce	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio pinifolius (L.) Lam.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.
Linum thunbergii Eckl. & Zeyh.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.
Anaxeton asperum (Thunb.) DC.	.	.	.	.	.	.	.	.	.	r	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Salvia africana L.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rochea subulata (L.) Adamson	.	.	.	+	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	+	.	.	.	.	.
Senecio erubescens Ait.	.	.	.	.	.	.	r	r	.	.	.	r	.	.	.	r	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.

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A number of good character species typify this community: *Thamnochortus gracilis*, *Hypodiscus aristatus*, *Anthospermum ciliare*, *Staberoha cernua*, *Prismatocarpus diffusa*, *Tetraria capillacea*, *Tetraria fasciculata*, *Willdenowia sulcata*, *Blaeria dumosa*, *Clutia polygonoides* and others (see Table 1). *Restio sieberi* is highly constant but common also to the *Restio perplexus* Community.

Many of the species common to the *Protea arborea—Rhus angustifolia* and the *Brunia nodiflora—Psoralea rotundifolia* Communities, are rare or absent here, but as Table 1 shows, there are many others, especially *Leucadendron adscendens* and *Tetraria bromoides*, that are common to all these communities.

The community occurs at fairly high altitudes (±500–800 m), on Table Mountain Sandstone soils of various depths. Slopes are moderate to steep (13°–34°). There is no prevalent aspect.

4. Restio perplexus *Community*

Although this community is only represented by three samples, it is, nevertheless, quite distinct from the other communities. The community is usually two-layered (undergrowth layer of herbs, sedges, grasses and dwarf shrubs 0,20–0,40 m high; shrub layer 0,60–1,50 m high), although there may be an open small tree layer 3–4 m high.

Restio perplexus appears to be a good character species. *Cliffortia polygonoides* and *Euryops abrotanifolius* are abundant and/or constant, but not strictly faithful (see Table 1).

Again, some species, for example *Clutia alaternoides*, are common to all four communities so far described, while many of the species generally occurring in either the first two communities or the first three communities are absent in this *Restio perplexus* Community. As already pointed out, this latter community has a number of species in common with the first *Protea arborea—Rhus angustifolia* Community. The relationship between these two communities is, however, not yet clear.

Relevé 34 cannot be unequivocally placed in this Community, because it contains species typical of the *Thamnochortus gracilis—Hypodiscus aristatus* Community. This relevé may be more heterogeneous than was thought, due to its position in a firebreak.

The community occurs at high altitudes (±800–1 100 m) on soils of ca. 50 cm depth on Table Mountain Sandstone. Steep slopes (25°–40°), with a general north-eastern aspect, seem typical.

5. Berzelia lanuginosa—Osmitopsis asteriscoides *Community*

This Fynbos community on seepage areas along drainage lines is very different from all others. The vegetation is dense, with an undergrowth of ca. 0,50 m high, a middle layer of sedges and shrubs 1–2 m high, and an open tree layer 3–5 m high. The permanently moist soil often contains a high percentage of organic matter.

Character species are thought to be *Berzelia lanuginosa*, *Osmitopsis asteriscoides*, *Carpha glomerata*, *Leucadendron salicifolium*, *Elegia capensis*, *Restio graminifolius*, *Cliffortia graminea*, *Tetraria punctoria*, *Elegia thyrsifera* and *Leptocarpus paniculatus*. Very few of the species common in the other Fynbos communities are present in this Community.

Riverine Scrub and Forest

The stream channels are generally fringed by woody vegetation. This is largely a dense scrub, but locally real forest occurs, especially where the valley narrows. Small patches of forest also occur on coarse, loose scree. These woody communities have a few faithful species in common (e.g. *Secamone alpini* and *Restio subverticillatus*) and there is a mutual overlap in species between the different communities (Table 2).

TABEL 2.—Forest and Riverine Scrub Communities

Relevé number	31	37	39	30	32	15	16	26
Total number of species	27	30	34	24	18	18	15	10
Altitude (m)	350	330	320	560	700	640	640	510
Aspect	N	N	N	N	NE	E	E	N
Slope (°)	0	0	0	15	25	35	35	15
Geology (g = Granite, T = Table Mt. Sandstone)	gT	gT	gT	gT	T	T	T	T
Soil depth (m)	1	1	1	1	—	—	—	—
Total cover (%)	100	100	100	95	85	90	90	85
Character species Brab. stell. **Comm.**								
Podalyria calyptrata Willd.	3	3	1	r	.	.	.	.
Brabeium stellatifolium L.	3	4	3	.	.	.	.	.
Halleria elliptica Thunb.	+	1	1	.	.	.	.	.
Blechnum capense (L.) Schlecht.	1	1	+	.	.	.	.	.
Pentameris thuarii Beauv.	r	+	+	.	.	.	.	.
Freylinia oppositifolia Spin,	2	+	.	.	.	.	.	.
Restio quadratus Mast.	+	.	+	.	.	.	.	.
Asparagus asparagoides (L.) Wight.	r	.	+	.	.	.	.	.
Mettrosideros angustifolia Smith.	.	.	4	.	.	.	.	.
Myrica serrata Lam.	.	1	.	.	.	.	.	.
Character species Rap. mel. **Comm.**								
Rapanea melanophloeos (L.) Mez.	.	.	.	3	2	.	.	.
Kiggelaria africana L.	.	.	.	1	1	.	.	.
Pellaea viridis (Forsk.) Prantl.	.	.	.	+	+	.	.	.
Asplenium aethiopicum Backer.	.	.	.	+	r	.	.	.
Character species Heer. arg. **Comm.**								
Heeria argentea (E. Mey.) Kuntze.	.	.	.	.	.	3	3	3
Rumohra adiantiformis (Forsk.) Ching.	.	.	.	.	.	1	1	.
Aloe mitriformis Mill.	.	.	.	.	.	1	+	.
Oftia africana (L.) Bocq.	.	.	.	.	.	+	+	.
Species common to Brab. stell., Rap. mel. **and** Heer. arg. **Comms.**								
Maytenus oleoides (Lam.) Loes.	1	1	.	2	+	1	2	.
Secamone alpini Schultes.	.	.	+	+	1	1	2	2
Hartogia schinoides (Thunb.) C. A. Smith	.	.	r	.	1	2	1	2
Restio subverticillatus Mast.	2	+	.	.	+	+	+	.
Blechnum punctulatum Sw.	1	.	1	2	+	.	r	.
Myrsine africana L.	.	.	+	+	.	+	.	+
Knowltonia capensis (L.) Muth.	+	.	.	+	+	+	.	.
Chironia baccifera L.	.	+	.	.	.	r	r	.
Species common to Rap. mel. **and** Heer. arg. **Comms.**								
Podocarpus elongatus (Ait.) Pers.	.	.	.	3	2	1	3	3
Olea africana Mill.	.	.	.	1	3	1	r	+
Maytenus acuminatus (L.f.) Loes.	.	.	.	3	2	+	.	1
Halleria lucida L.	.	.	.	1	1	.	r	+
Zantedeschia aethiopica Spreng.	.	.	.	.	+	1	+	+
Olinia cymosa Thunb.	.	.	.	1	2	.	.	4
Species common to Brab. stell. **and** Rap. mel. **Comms.**								
Asparagus scandens Thunb.	+	.	1	1	+	.	.	.
Cunonia capensis L.	1	r	.	.	+	.	.	.
Ilex mitis (Jacq.) Radlk.	1	.	2	2	.	.	.	.
Brachylaena neriifolia (L.) R. Br.	.	2	2	+	.	.	.	.
Oplismenus hirtellus (L.) Beauv.	r	.	+	r	.	.	.	.
Other intruding species								
Ehrharta ramosa Thunb.	+	1	+	.	.	.	.	.
Pteridium aquilinum (L.) Kuhn.	+	1	+	.	.	.	.	.
Asparagus thunbergianus Schult. f.	+	+	+	.	.	.	.	.
Rhus angustifolia L.	+	+	+	.	.	.	.	.
Cassytha ciliolata Nees.	+	+	+	.	.	.	.	.
Diospyros glabra (L.) de Winter.	+	+	.	+	.	.	.	.
Cliffortia cuneata Ait.	1	+	+	.	.	.	.	.
Aristea thyrsiflora (Delar.) N.E. Br.	+	+	.	.	.	.	.	.
Restio gaudichaudianus Kunth.	.	+	+	.	.	.	.	.
Elegia capensis (Burm.f.) Schelpe.	.	1	+	.	.	.	.	.
Carpha glomerata Nees.	+	.	r	.	.	.	.	.

6. Brabeium stellatifolium *Community*

This dense scrub up to 5 m high fringes the lower, less steep parts of the streams. Character species include *Brabeium stellatifolium*, *Podalyria calyptrata*, *Halleria elliptica*, *Blechnum capense*, *Pentameris thuarii*, *Freylinia oppositifolia* and others. More information might necessitate subdivision into two communities, one with the character species *Meterosideros angustiolia*, and the other lacking it.

7. Rapanea melanophloeos *Community*

This community constitutes the largest part of the forest vegetation. It occurs at higher altitudes along stream channels, with steep gradients. Further downstream the rivers are fringed by the *Brabeium stellatifolium* Community.

There are two tree layers. The highest reaches 10–12 m, the other 5–8 m, beneath which is a "layer" largely formed by saplings. There is no shrub layer and very little undergrowth. Character species of the community are *Rapanea melanophloeos* and, possibly, *Kiggelaria africana*, *Pellaea viridis* and *Asplenium aethiopicum*.

8. Heeria argentea *Community*

This forest community occurs in small patches on coarse, loose screes. There is usually a singly tree layer, with an average height of 7–8 m, sometimes reaching 10 m. The undergrowth consists of herbs and small shrubs up to 0,60 m high with a low cover. The trees are covered with lichens and mosses, indicating that moisture condensation often occurs.

Character species are *Heeria argentea*, which has a high cover, and possibly *Rumohria adiantiformis*. The species *Aloe mitriformis* and *Oftia africana* may also be considered character species of the undergrowth where the tree canopy is open.

The two *Rapanea* and *Heeria* forest communities in Swartboschkloof have some species in common of which *Podocarpus elongatus* is the most abundant. This species and other common species, such as *Olea africana*, *Maytenus acuminatus*, *Hartogia schinoides* and *Olinia cymosa*, all form canopy trees, while *Halleria lucida* and *Myrsine africana* occur regularly in the understory.

Discussion

The main purpose was to test the Braun-Blanquet phytosociological method on the floristically rich Fynbos vegetation. In that a practical classification into communities based on floristic criteria has been possible, and because these communities can be correlated with definite environmental factors, we may conclude that the Braun-Blanquet method can be successfully applied to the analysis of Fynbos vegetation. This contradicts Donselaar's statement (1965) that the species number must be moderate if the method is to be successful.

Walter (1968) states that, on the South-west Cape mountains near the coast, aspect plays a more important rôle than altitude. The rather strict aspect preferences of the *Protea arborea—Rhus angustifolia* and the *Brunia nodiflora—Psoralea rotundifolia* Communities seem to confirm this, although the *Thamnochortus gracilis—Hypodiscus aristatus* Community does not show any aspect preference, and is correlated in Swartboschkloof with altitude and geological substrate. However, it is difficult to distinguish whether altitude or geological substrate is the more important, since these two factors are correlated with each other.

Adamson (1931) sampled the vegetation of north and west slopes of Table Mountain between 300 and 360 m, on granite with overlying Table Mountain Sandstone talus, in order to find "some explanation of the apparent variability of the floras" of the communities which he floristically distinguished. Although he noted that "the floristic composition of a community must ultimately be its most important characteristic", he could not prove this when he tried to express it in terms of species dominance, concluding that there was life-form dominance rather than species dominance. Nevertheless, our results show that when floristic composition is used as a criterion, it is indeed possible to characterize communities.

It is remarkable that conspicuous vegetational structures do not always coincide with the boundaries of communities defined upon floristic composition. We find the dense sclerophyllous *Protea neriifolia* and *Protea repens* dominated scrub distributed in the three most common Fynbos communities, although mainly concentrated in the *Protea arborea—Rhus angustifolia* and the *Brunia nodiflora—Psoralea rotundifolia* communities. The relationships between physiognomic structure and phytosociological classification have been discussed by Westhoff (1968). He uses the term "Twin Formation" for "strata which vary independently on [of] each other", or "stands which are floristically hardly, but structurally considerably different." These situations occur where extreme habitat factors prevail. Burning is considered to be such an extreme factor. Donselaar (1965) found that in the Surinam savannas the floristic composition of some treeless areas was so similar to the undergrowth of a certain type of tree savanna, that they should both be placed in the same association, arguing that the floristic principle should predominate over the structural one. Dansereau & Arros (1959), who favour the principle of structure, argue that decisions of the kind similar to the above are too arbitrary and they doubt the reality of such associations.

Since Fynbos is recurrently burned and the structure of the Fynbos is very often closely related to the elapse of time since the last burning, we feel, like Donselaar (1965), that a floristically based system of communities is more consistent and practical.

It is interesting to note that Tables 1 and 2 show the intrusion into the *Brabeium stellatifolium* and *Berzelia lanuginosa—Osmitopsis asteriscoides* Communities of some species that usually occur in other Fynbos. Such species are *Asparagus thunbergianus*, *Rhus angustifolia*, *Rhus rosmarinifolia*, *Diospyros glabra*, *Aristea thysiflora*, *Cliffortia cuneata*, *Erica hispidula*, *Protea neriifolia*, *Anthospermum aethiopicum* and *Ehrharta ramosa*. Both the *Brabeium stellatifolium* and the *Berzelia lanuginosa—Osmitopsis asteriscoides* Communities occur only as long narrow strips of vegetation along stream channels and seepage lines. The Communities are thus characterized by a high ratio of margin to surface area, or a large "edge effect." Because of this large "edge effect," intruding species from surrounding communities are more likely to be found throughout such long narrow communities compared with communities of another shape. Species that are most likely to intrude are those with a wide ecological amplitude, as appears to be the case for some of the species listed above. Other intruding species, like *Pteridium aquilinum* and *Cassytha ciliolata*, seem to be ones with their optimal occurrence in ecotones, especially ecotones of a shrubby nature. In Leeuwen's (1966) terminology they can be called species of the "limes convergens", that is species living under unstable conditions, usually as large numbers of individuals.

Adamson (1927) and Walter (1968) point out that on the Table Mountain Plateau *Schizaea pectinata* can be very abundant and proves to be a good indicator of fire. In Swartboschkloof this species was not abundant, however, and was not present in the quadrats sampled on the firebreaks. Adamson (1935) found that after a fire in the vegetation on the slopes of Table Mountain, *Euryops abrotanifolius* increased quickly during the first three years and was dominant for the following two years. From then on the species decreased rapidly. Our results from Swartboschkloof also link *Euryops abrotanifolius* with the fire factor. In quadrats 34 and 35, situated on the firebreak, it scored cover-abundance values of 2 (5–25 %), whereas it occurred in only two other quadrats, in old stands, with low values.

Floristic data on Fynbos vegetation in the literature are limited, and complete species lists of quadrat samples are unavailable. It is, therefore, difficult to link the Communities presently distinguished, with communities described in other Fynbos literature. As early as 1908, Marloth presented an outstanding description of the flora and vegetation of the Cape, describing the vegetation on a structural and geographical basis. In his general descriptive account of the vegetation of Table Mountain, Adamson (1927) mentions a number of species from the "....plateau communities on sandy soils....", which are typical of the *Thamnochortus gracilis—Hypodiscus aristatus* Community described here. The habitat and altitude of these two communi-

ties also show similarities. Further study may show closer correlations. In addition, the Communities he briefly described from seepage areas and along stream channels, show floristic similarities, through species such as *Berzelia lanuginosa* and *Osmitopsis asteriscoides*, with those of Swartboschkloof. The same is true for gorge forest and riverine scrub communities in both areas.

Taylor (1969) mentions, among others, *Pentaschistis colorata* and *Staberoha cernua* as preferential species for one of two communities forming a mosaic in the "plateau fynbos association" in the Cape of Good Hope Nature Reserve. It is probable that this community is related to the *Thamnochortus gracilis—Hypodiscus aristatus* Community. Certainly, his "*Osmitopsis* seepage scrub association" is closely related to our *Berzelia lanuginosa—Osmitopsis asteriscoides* Community. His description of the *Protea arborea* pseudo savannah association" (waboomveld; Taylor, 1963), with typical species *Protea arborea, Montinia caryophyllaceae, Rhus rosmarinifolia, Leucospermum conocarpodendron, Themeda triandra, Hermannia cuneifolia, Cymbopogon marginatus* and *Bobartia incica*, strongly suggests it belongs to the *Protea arborea—Rhus angustifolia* Community.

Relevés from the Fynbos are expected to accumulate and will enable ecologists to classify the vegetation in a hierarchical system of associations, alliances, orders and classes. A special difficulty in classifying the complete Fynbos vegetation lies in the fact that many species have a very limited distribution. This will make it necessary to distinguish geographical races of an association, or regional associations with a limited geographical extension. Communities earn the status of an independent regional association only if they have their own character species and alliance character species, as pointed out by Oberdorfer (1968). If they differ only in the accompanying species, they are geographical races of one association. Problems of this nature will need to be handled very carefully in classifying Fynbos vegetation.

It is inevitable in such a survey that some quadrats will be badly sited. They may either fall on an ecotone (probably Quadrat 34), or give an unrepresentative picture of the vegetation type to which they belong (Quadrat 27), or represent a different vegetation which is clearly undersampled (Quadrat 22). All such samples are usually left out of the association table, because they do not contribute to an understanding of the vegetation. Quadrats which are wrongly sited cannot be used, but if they represent an undersampled community, as in Quadrat 22, they should be kept until more information becomes available. We have here included these stands in Table 1 to give an example of sampling errors.

Many more relevés, especially from elsewhere in the Fynbos are required for a successful phytosociological classification (see Tüxen, 1970). We have not presented a formal hierarchical system here because of a lack of data; this report should be regarded as a challenge to South African ecologists to prove and improve the classification and so to build up an understanding of the vegetation.

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Samevatting

Die fitososiologiese metode volgens Braun-Blanquet is getoets in die komplekse Fynbos vegetasie van die Suidwes-Kaap in Suid-Afrika. In die Swartboschkloof Natuurreserwe, Jonkershoek, is die Fynbos, die oewerstruikgewas en die woudvegetasie voorlopig in agt gemeenskappe ingedeel. Hierdie gemeenskappe is floristies beskryf en die verband tussen die gemeenskappe en sekere habitatfaktore is aangedui. Die resultate is belowend en die moontlikhede om die Kaapse Fynbos te kan klassifiseer in 'n formele fitososiologiese sisteem is bespreek.

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Appendix

Species excluded from Table I (relevé numbers and cover-abundance values in brackets)

Ehrharta capensis Thunb. (1: +)
Chironia baccifera L. (2: +)
Hibiscus aethiopicus L. (2: +)
Hartogia schinoides (Thunb.) C. A. Smith (3: r)
Myrsine africana L. (3: +)
Stoebe aethiopica L. (3: +)
Crassula obvallata L. (4: +)
Senecio umbellatus L. (4: +)
Apodytes dimidiata E. Mey. ex Benth. (5: r)
Halleria elliptica Thunb. (5: 1)
Stoebe aethiopica L. (8: +)
Tetraria compar (L.) Lestib. (8: +)
Cliffortia subsetacea Diels ex Bol. (10: r)
Halleria elliptica Thunb. (12: +)
Struthiola ciliata (L.) Lam. (13: +)
Adenandra uniflora Willd. (14: +)
Centella virgata (L.f.) Druce (14: +)
Danthonia lupulina R. & Schult. (14: r)
Eragrostis curvula (Schrad.) Nees (14: +)
Heterolepis aliena (L.f.) Druce (14: +)
Osteospermum spinosum L. (14: +)
Carpacoce spermacocea (Reichb.) Sond. (18: +)
Epischoenus villosus Levyns (18: +)
Gleichenia polypodioides Sm. (18: +)
Pelargonium angulosum Ait. (19: r)
Struthiola ciliata (L.) Lam. (19: r)
Protea cynaroides L. (20: r)
Apodytes dimidiata E. Mey. ex Benth. (21: r)
Berzelia intermedia Schld. (21: +)
Elegia asperiflora Kunth (22: 1)
Elegia vaginulata Mast. (22: 5)
Chrysanthemoides monolifera (L.) T. Norl. (23: +)
Ehrharta calycina Sm. (23: +)
Pelargonium pinnatum (L.) L'Her. (23: +)
Rhynchosia capensis (Burm.) Schinz (24: +)
Erica racemosa Thunb. (25: +)
Leptocarpus sp. (25: +)
Pseudognidia anomala Phillips (25: r) (27: r)
Ficinia capillaris Levyns (28: +)
Leptocarpus sp. (28: +)
Pelargonium tabulare (L.) L'Her. (28: +)
Peucedanum sieberianum Sond. (29: +)
Asplenium aethiopicum Bacher (33: r)
Chironia baccifera L. (33: 1)
Myrsine africana L. (33: 3)
Pentameris thuarii Beauv. (33: +)
Psoralea pinnata L. (33: 1)
Zantedeschia aethiopica Spreng. (33: +)
Athrixia heterophylla (Thunb.) Less. (34: +)
Castalis nudicaulis (L.) T. Norl. (34: +)
Erica longifolia Ait. (34: +)
Ficinia zeyheri Boeck. (34: +)
Gnidia juniperifolia Lam. (34: +)
Leontonyx glomeratus (L.) DC. (34: +)
Peucedanum sieberianum Sond. (34: +)
Selago serrata Berg. (34: +)
Tetraria involucrata (Rottb.) C.B. Cl. (34: +)
Ursinia dentata (L.) Poir. (34: +)
Ficinia trichodes (Schrad.) Benth. ex Hk.f. (35: 1)
Pelargonium tabulare (L.) L'Her. (35: +)
Pentaschistis aristidoides (Thunb.) Stapf (35: 1)
Senecio bipinnatus (L.f.) Less. (35: +)
Ehrharta calycina Sm. (36: r)
Olea africana Mill. (36: r)
Asparagus scandens Thunb. (38: r)
Blechnum capense (L.) Schlecht. (38: +)
Centella eriantha (Rich.) Druce (38: +)
Halleria lucida L. (38: 1)
Kiggellaria africana L. (38: +)
Myrica serrata Lam. (38: +)
Psoralea pinnata L. (38: +)
Rapanea melanophloeos (L.) Mez. (38: +)
Rubus cf. *rigidus* Smith (38: +)
Tetraria cf. *cuspidata* (Rottb.) C.B. Cl. (38: 2)
Zantedeschia aethiopica Spreng. (38: +)
Danthonia cincta Schrad. (40: 1)
Elegia asperiflora Kunth (40: 2)
Erica intervallaris Salisb. (40: +)
Juncus capensis Thunb. (40: r)
Restio quadratus Mast. (40: +)
Tetraria flexuosa (Thunb.) C.B. Cl. (40: r)
Erica cerinthoides L. (41: +)
Crassula obvallata L. (43: r)

Crassula scabra L. (43: +)
Eragrostis capensis (Thunb.) Trin. (43: +)
Eroeda capensis (L.) Levyns (43: r)
Heterolepis aliena (L.f.) Druce (43: +)
Heteropogon contortus (L.) Beauv. (43: +)
Pellaea pteroides (L.) Prantl (43: 1)
Pentaschistis juncifolia Stapf (43: r)
Plagiochloa uniolae (L.f.) Adams. & Sprague (43: +)
Anemone capensis L. (44: r)
Aspalathus crenata (L.) R. Dahl. (44: +)
Eroeda capensis (L.) Levyns (44: r)
Metalasia cephalotes (Thunb.) Less (44: 1)

Species excluded from Table II (relevé numbers and cover-abundance values in brackets).

Ficinia capillaris Levyns (15: r)
Heterolepis aliena (L.f.) Druce (15: +)
Sutera hispida (Thunb.) Druce (15: +)
Viscum rotundifolium L.f. (16: +)
Anthospermum aethiopicum L. (30: r)
Leonotis leonurus R. Br. (30: +)
Schoenoxipheum lanceum (Thunb.) Kukenthal (30: +)
Leptocarpus paniculatus Pillans (31: +)
Struthiola myrsinites Lam. (31: +)
Cliffortia atrata H. Weim. (37: 1)
Erica plukeneti L. (37: +)
Phylica pubescens Ait. (37: +)
Protea arborea Houtt. (37: r)
Protea neriifolia R. Br. (37: r)
Schizaea tenella Kaulf. (37: r)
Stoebe plumosa (L.) Thunb. (37: +)
Thesium strictum Berg. (37: r)
Centella eriantha (Rich.) Drude (39: +)
Cyperus congestus Vahl (39: +)
Helichrysum odoratissimum (L.) Sweet (39: +)
Osteospermum ciliatum Berg. (39: +)
Othonna quinquedentata Thunb. (39: +)
Pelargonium vitifolium Ait. (39: +)
Psoralea cordata (L.) Salter (39: +)
Psoralea fruticans (L.) Druce (39: +)
Scirpus sp. (39: r)

PLATE 1.—General view of Swartboschkloof Nature Reserve. Foreground vegetation mainly **Protea arborea—Rhus angustifolia** Community; slopes of centre mountain ridge mainly **Brunia nodiflora—Psoralea rotundifolia** Community; right centre **Heeria argentea** Community on scree (Photo: F. J. Kruger).

PLATE 2.—**Protea arborea**—**Rhus angustifolia** Community. Tree on right **Protea arborea;** foreground mainly **Tetraria bromoides.** Note **Rapanea melanophloeos** Community in ravines in background (Photo: F. J. Kruger).

PLATE 3.—**Brunia nodiflora**—**Psoralea rotundifolia** Community. Left flowering **Brunia nodiflora;** right restionaceous plants (Photo: F. J. Kruger).

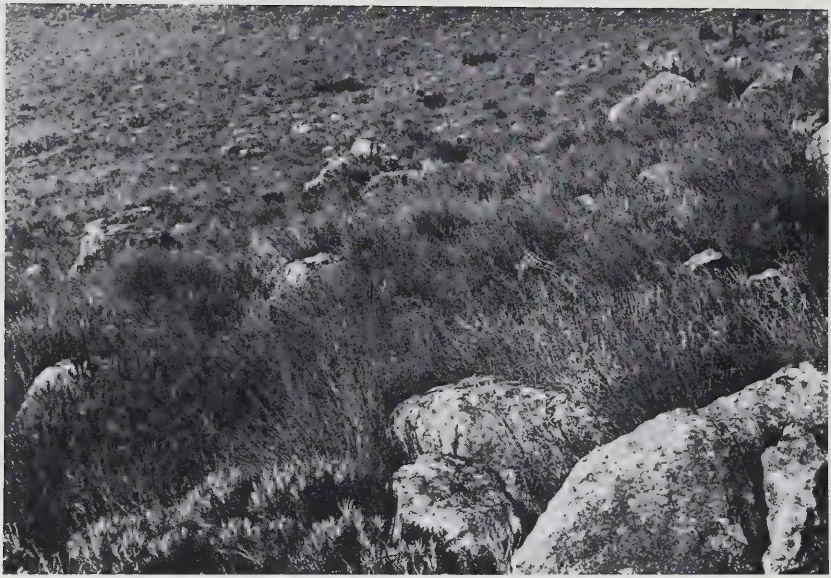

PLATE 4.—**Thamnochortus gracilis—Hypodiscus aristatus** Community showing restionaceous character (Photo: F. J. Kruger).

PLATE 5.—**Rapanea melanophloeos** Community in steep ravines (Photo: F. J. Kruger).

Bothalia, 10, 4: 615–626

A Preliminary Account of the Dune Communities at Pennington Park, Mtunzini, Natal

by

E. J. Moll*

Abstract

A general description of Pennington Park is given, and some of the more important environmental factors affecting the plant communities are discussed. The structure, distribution and ecology of the various dune communities, from pioneers to Dune Forest, is given. The importance of Pennington Park as a conservation area is discussed in the light of the paucity of comparable sites and the human pressure on this type of environment.

Introduction

During 1960 and 1961 two parties of students from Natal University, Pietermaritzburg, visited Pennington Park, on the farm "Twinstreams" in Zululand, to study the dune vegetation. Various ecological surveys and physiological experiments were conducted on the dune vegetation, and two preliminary reports were compiled (Anon, 1960, 1961). These reports, which contain some interesting data, were not published so the results of this work have hitherto not been available. The area studied is the only place in Natal where there is significant active and extensive sand deposition, dune formation, dune stabilization and colonization. It was decided, therefore, to extract data from the two University reports and to add additional and recent observations in an attempt to describe, in reasonable detail, the ecology of the dune pioneers and their successors. There is a need for these observations to be generally available because, with the development of Richard's Bay harbour, 35 km to the north, Mtunzini has been ear-marked for considerable tourist development. Such development would certainly have a severe detrimental affect on the dune communities, which are highly susceptible to disturbance. Thus a unique kind of vegetation is threatened.

That the dune communities of the area are still well protected is due almost entirely to the conservation efforts of a local farmer, Mr. I. F. Garland, on whose farm "Twinstreams" most of the Dune Forests occurs. Also, part of the coastral strip, between the Dune Forest and the sea, is administered by the Natal Parks, Game and Fish Preservation Board and is included in the Umlalazi Nature Reserve (Fig. 1). This latter area is open to the public so the dune communities are threatened unless adequate measures can be taken to prevent inappropriate utilization of the dunes.

Location and Physiography

The area under consideration is situated on the east coast of Natal at the southern extremity of the Moçambique coast plain, approximately 130 km north-east of Durban, at lat. 28°58'S and long. 31°46'E. The beach profile slopes gently up from the sea to the extreme high tide mark, then rises sharply in a series of steeply undulating dunes (Plate 1), which are almost parallel to the coast and up to 10 m high. Sand is actively deposited off-shore and new dunes are continually being found. Under present conditions it takes approximately 10 years to stabilize a dune (Plate 2).

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PLATE 1.—A general view of the beach showing the gently sloping beach and the line of steep, **Scaevola** covered, dunes. Note the **Scaevola** seeds at the foot of the dune in the foreground, and also the scattered **Scaevola** plants on the beach—these plants mark the line of the next new dune.

PLATE 2.—The stable dune in the foreground is mainly covered by **Scaevola,** but other dune pioneers also occur. The fore-dune shown, is about 10 years old and stabilized almost exclusively by **Scaevola.**

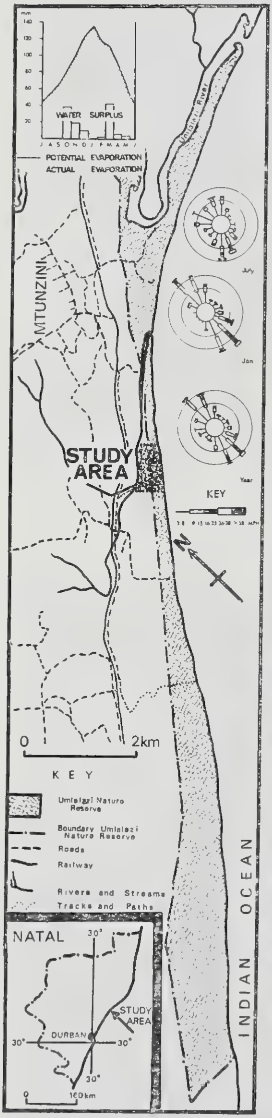

FIG. 1.—Map showing the location of the study area, the extent of the Umlalazi Nature Reserve, the important wind roses (Weather Bureau, 1960), and the water balance (Thornthwaite & Mather, 1962) for Mtunzini area.

The soils on the more recent dunes are a light yellowish brown fine sand, with no humus and a pH of about 7,8. On the older dunes, which support a closed woody community of Dune Forest, the soils are very dark greyish-brown sands, with a relatively high humus content and a pH of between 7,2 and 7,4. Along the banks of the Siayi Lagoon the alluvial soils are a grey to black clay-loam, with a high gritty content and a pH of about 6,4.*

Climate

Detailed climatic data for the area are available only from Durban, which is on the coast, but is 130 km SW of Mtunzini. The only data available locally are rainfull records.

The prevailing winds are mainly from the NE and SW quarters. Winds are an important factor influencing plant growth, particularly those strong winds which blow off the sea, carrying salt-spray. The effect of this wind-borne salt-spray has been discussed frequently in the literature (e.g. Bews, 1920; Henkel, Ballenden & Bayer, 1936; Bayer, 1938, 1952; Hillary, 1947; Edwards, 1967; and Moll, 1968), but has not been studied in detail. It is generally considered that the wind-borne salt-spray is deposited on the windward side of plants killing growing points, resulting in the lopsided growth of woody plants and the pruned-hedge effect of the Dune Forest canopy (Plate 3).

Plate 3.—An example of the pruning effect of wind carried salt-spray on the Dune Forest canopy at Mapelana (about 90 km NE of Mtunzini), where old, steep dunes come right down to the beach.

* Soil descriptions follow the terminology of Loxton, 1962. Initial soil pH determinations were made using a Lovibond Colorimetric Comparator and checking these with a pH meter.

Winds which bring most salt-spray blow chiefly from September to January (see wind rose insets in Fig. 1) and often reach a speed of 16–25 MPH (26–40 km/h), gusts of up to 88 MPH (140 km/h) having been recorded (Weather Bureau, 1960). These strong winds usually blow between 8 a.m. and 10 p.m.

Rainfall data are available from Mtunzini and have been summarized in Table I.

TABLE I.—Mean monthly and annual rainfall recorded at Mtunzini over a 53 year period (Weather Bureau, 1954).

Month	J	F	M	A	M	J	J	A	S	O	N	D	Year
Rainfall in mm	134,8	146,2	141,0	98,8	79,8	59,7	51,7	49,2	85,2	103,9	112,9	141,3	1 204,5
Days with rain	8	7	7	5	4	3	3	4	5	8	8	7	69

Summer is the wettest season, although a reasonable amount of rain occurs throughout the year. Temperatures are relatively mild, and data available from Durban, covering a period of 76 years, record an absolute minimum of 4,1°C in July 1947 and an absolute maximum of 41,9°C in September 1946. The mean annual temperature is 20,5°C with a mean daily range of 8,3°C. Under this climatic régime of moderate temperatures and good rainfall there is seldom, if ever, a soil water deficit (see Thornthwaite & Mather, 1962; and diagram inset Fig. 1), so conditions for plant growth are very good. Mtunzini, being 130 km NE of Durban, is rather more subtropical, so minimum and maximum temperatures are probably higher.

VEGETATION

The most important first pioneer of the shifting sand on the beach is *Scaevola thunbergii*. Some other pioneers of minor importance are *Launnaea sarmentosa* and *Arctotheca populofolia*. The *Scaevola* colonies form an open, scattered community up to about one metre tall. *Scaevola* seeds are round and light, and roll down the dunes (Plate 1) from whence they are readily blown about. *Scaevola* is capable of continuous stem elongation and adventitious root production from sand-covered stems, and thrives where moving sand is continually covering existing communities. *Scaevola* is tolerant of salt-spray and at Mtunzini seldom occurs beyond the fourth dune. Healthy *Scaevola* colonies are dominant on the first and second dunes, and in areas on the third dunes where disturbance has caused shifting sand. On the third and fourth dunes, where *Scaevola* is also common, the plants are weak as a result of the dunes being relatively stable. This weakened community, where the lateral stems are usually exposed, is readily invaded by other pioneers such as *Ipomoea biloba* (Plate 4), *Canavalia pes-capre*, *Gazania rigens*, *Chrysanthemoides monilfera* and *Tephrosia canescens*, all species which require a relatively stable substrate.

Once the dunes have been stabilized and there has been sufficient modification of the soil by the pioneer plants, shrub species, particularly *Passerina rigida*, invade the pioneer strand communities. The shrub species nearest the sea grow in the dune troughs, usually 60 to 70 m from the high tide mark (Plate 5). Other shrub species usually occur further inland, such as *Eugenia capensis*, *Colpoon compressum*, *Carissa bispinosa* and *Brachylaena discolor*. Certain Dune Forest canopy trees occur as shrubs in the Dune Scrub Community, especially *Mimusops caffra*, *Apodytes dimidiata*, *Allophylus natalensis* and *Canthium obovatum* (Plate 6). The Dune Scrub near the sea is up to 2 m high forming a widely scattered community, which becomes progressively denser and taller (up to 3,5 m) further inland towards the Dune Forest (Plate 7). This trend is well illustrated in Figs. 2 and 3.

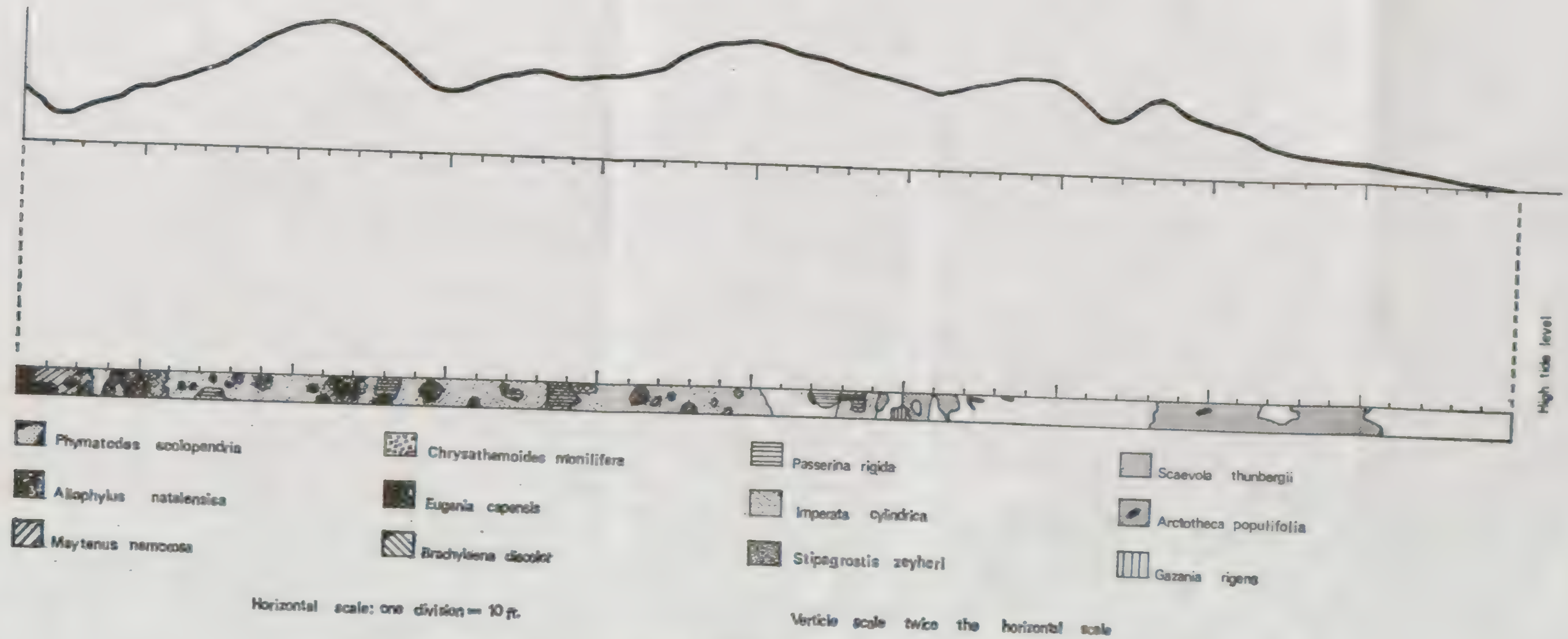

FIG. 2.—Land profile and extent of vegetation cover on a 3 m belt transect (Anon, 1960).

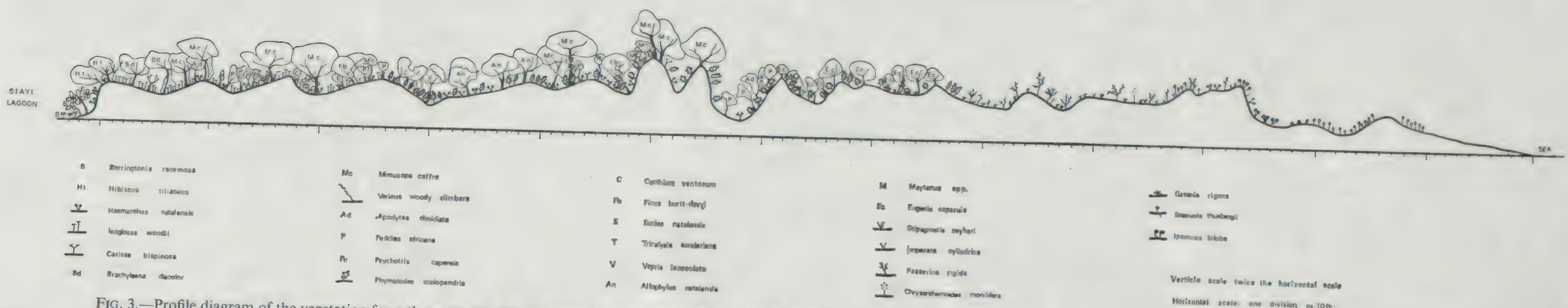

FIG. 3.—Profile diagram of the vegetation from the sea to the Siayi Lagoon. The depth of the profile was 1 m in the pioneer strand and Dune Scrub Communities, and 4,5 m in the Dune Forest (Anon, 1961).

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PLATE 4.—Showing a healthy **Scaevola** community growing in shifting sand on the left. **Scaevola** is also common on the stable dune on the right, but many lateral stems are exposed; note the long runners of **Ipomoea** in the dune trough.

PLATE 5.—The first stage of Dune Scrub Community development is the invasion of the pioneer strand communities by **Stipagrostis** (the tuft grass pictured) and **Passerina** (right). Note the scattered **Scaevola** plants, particularly on the dune (left).

PLATE 6.—In the later stages of the Dune Scrub Community **Imperata** is the chief understorey species. The shrubs are more dense, with Dune Forest species, such as **Mimusops** (left), being more common. Note the dead **Passerina** (right-centre).

PLATE 7. -A general view of the Dune Scrub Community from the **Scaevola** dominated foredune' illustrating the invasion of the strand community by **Stipagrostis** and **Passerina,** followed by other shrub species and finally Dune Forest being established.

PLATE 8.—Dune Forest with **Phymatodes scolopendria** forming the dominant understorey herbaceous layer.

Another distinct change in the Dune Scrub Community, as one moves inland, is that first *Stipagrostis zeyheri* (Plate 5), and then *Imperata cylindrica*, both grasses, form a fairly dense understorey up to 0,75 m high, being most dense away from the sea. Various other herbaceous species occurring scattered through the Dune Scrub Community include *Helichrysum kraussii*, *Kalanchoe* sp., *Senecio* sp., *Carpobrotus dimidiata*, *Chironia baccifera* and *Gloriosa* sp. In addition, various lianes also occur, such as *Scutia myrtina*, *Dalbergia armata*, *Asparagus falcatus* and *Rhoicissus* spp., particularly *R. digitata*. In the shade of the shrubs on the dune just seaward of the Dune Forest, *Phymatodes scolopendria* is a common understorey herb.

The margin of the Dune Forest is sharply demarcated, beginning just behind the crest of a dune (see Figs 2 and 3). When walking at right angles to the sea one is inside the forest one instant and then outside within a couple of paces. The tree species forming the closed canopy (some 7 to 8 m high) nearest the sea are *Mimusops caffra*, *Allophylus natalensis*, *Eugenia capensis*, *Maytenus nemorosa*, *Euclea natalensis* and *Canthium obovatum*. Shrub species beneath the closed canopy are not common, nor are lianes. What is apparent, forming a very dense field layer, is *Phymatodes scolopendria* (Plate 8), up to 0,5 m high, which is the dominant field layer species over the next four dunes, when it suddenly gives way to a dense community of *Isoglossa woodii* (Plate 9)*. Further from the sea, and to a very limited extent in the dune troughs, the canopy tree species are taller, reaching a maximum height of about 15 to 17 m. An unexpected feature of the forest is that the external appearance of the canopy does not exhibit the usual dense, pruned-hedge effect of the Dune Forest as in other parts of Natal, because the forest is a fair distance from the sea and the salt-spray effect is much reduced.

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* The soil pH where *Phymatodes* dominates is the same as under Dune Scrub Communities, namely, 7,4, while the soil pH where *Isoglossa* dominates is 7,2.

PLATE 9.—Dune Forest with **Isoglossa** forming the dominant understorey herbaceous layer.

The older the Dune Forest, the more complex is the structure and the richer is the floristic composition. Some canopy tree species which occur further away from the sea are *Dovyalis longispina*, *Olea woodiana*, *Vepris lanceolata*, *Scolopia zeyheri*, *Trichilia emetica* and *Ekebergia capensis*. Beneath the continuous canopy is a rather ill-defined intermediate small tree and shrub layer of scattered individuals such as *Carissa bispinosa*, *Peddiea africana*, *Turraea floribunda*, *Psychotria capensis*, *Bersama lucens*, *Acokanthera oblongifolia*, *Tricalysia capensis* and *Teclea gerrardii*. Additional species which may occur scattered through the herbaceous field layer are *Haemanthus*, *Crocosmia aurea*, *Eulophidium* sp. and various species of Acanthaceae. Where *Isoglossa* occurs there are usually few herbaceous or intermediate species present due to the performance of *Isoglossa*. This species grows in extremely dense stands up to 3 m high, the whole population then flowers in the same year, dies off, and then regrows over a period of approximately seven years to complete the cycle. Thus Dune Forest with *Isoglossa* understorey can look either extremely dense, when the *Isoglossa* us 2 to 3 m high, or extremely open, when the *Isoglossa* seedlings carpet the ground.

The presence of the Dune Forest means that there is a great enrichment of the soil by humus, which is usually 10 cm and more thick. In this subtropical climate the rate of breakdown of vegetable matter on the forest floor is rapid, and numerous species of saprophytic fungi occur.

Lianes are not common in old, established Dune Forest, except where a natural tree fall has created a gap. In such gaps there develops a dense tangled mass of vegetation, but eventually a canopy tree grows through this to close the canopy. Lianes that do occur fairly frequently in the forest are *Dalbergia armata*, *Rhoicissus* sp., *Cyphostemma* sp., *Acacia kraussiana* and *Scutia myrtina*. The absence of *Flagellaria guineensis* is worthy of note.

Running through the Dune Forest at Pennington Park, almost parallel to the coast, is the Siayi Lagoon (Fig. 1). On either bank there is a dense fringing tree community of mainly *Barringtonia racemosa* and *Hibiscus tiliaceus* (Plate 10). Climbers such as *Derris uliginosa* and *Dalbergia armata* are particularly common in this community, the former growing in the wet muddy soils of the lagoon bank.

PLATE 10.—A view of the Siayi Lagoon where the fringing tree community of **Barringtonia** forms an arch over the water.

DISCUSSION

In Natal there are no examples of viable Dune Forest communities represented in a Nature Reserve, except for this example in the Umlalazi Nature Reserve and the adjoining farm "Twinstreams". With the development of Richard's Bay and the proposed development of a giant marina on the Umlalazi River, with a possible link to the Siayi Lagoon, this area is threatened. It has been demonstrated in other parts of Natal that the Dune Forest and pioneer strand communities are highly susceptible to human interference. Therefore, a special attempt should be made by conservationists to preserve a viable representative of this community. It should also be the aim of conservationists to preserve other examples of dune vegetation to the north and south of Mtunzini to include the full spectrum of types occurring. Much of this type of community has already disappeared in Natal, and the time to act is now.

ACKNOWLEDGEMENTS

I am particularly grateful to Mr. I. F. Garland for his generosity and active assistance while I have worked on this report.

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The Distribution, Abundance and Utilization of the Lala Palm, *Hyphaene natalensis*, in Tongaland, Natal

by

E. J. Moll*

Abstract

The distribution of the Lala Palm, *Hyphaene natalensis*, in Tongaland and Northern Zululand, is mapped; the Palm occupies an area of about 156 000 ha. The total number of individuals is estimated at approximately 10 500 000 and the total yield in leaves per year is estimated at about 33 000 000. The exploitation of the leaves for fibre could be an economic proposition, but communications in the region are poor and the area is extremely large. Present utilization of the Lala Palm, by the Bantu is considered.

Introduction

Recently it has been suggested that the leaves of the Lala Palm, *Hyphaene natalensis*†, in Tongaland, which yields an excellent fibre, should be reaped and processed for the fibre. However, before embarking on such a scheme it was considered desirable to study the distribution, abundance and present utilization of the Lala Palm with a view to assessing the feasibility of the scheme.

Tongaland has been defined as that part of Natal which lies east of the Lebombo Mountains, north of the Mkuzi River and St. Lucia, and south of Mozambique (Campbell, 1969). For the most part it is flat to gently undulating country about 14,7 to 44 m above sea level, until it rises sharply in the west to the Lebombo Mountains. A feature of Tongaland that is uncommon in Natal is the presence of numerous pans and lakes, namely the Pongola flood plain and environs (Coke & Pott, 1970), the Mosi Swamp running more or less north to south, and the series of coast lakes including the Kosi System and Lake Sibayi (see Fig. 1). In addition, there are numerous ephemeral, as well as a few permanent pans and swamps scattered through the country east of the Mosi Swamp to the sea.

The Tongaland or Mozambique Plain, as the flat coastal plain is called, is a recently uplifted area of marine sands. From the coast to the Lebombo the soils change from white to grey sands, to red sands across the Pongola, and to Cretaceous soils in the Lebombo foothills. The soils occupied by the Lala Palms are the grey ands white sands.

Few climatic data are available from the area. It is known, however, that the average summer rainfall along the coast is about 1 200 mm and that this falls off steadily as one moves inland to about 600 to 700 mm along the Pongola River. There is little, if any, rainfall in winter. It is fairly safe to assume, therefore, that the average annual rainfall between the Mosi Swamp and the sea, which is the main palm belt (see Fig. 1), is between 900 and 1 200 mm. No temperature data are available from the area, but it is known that in winter minimum temperatures are not sufficiently low to allow even light frost, and that maximum temperatures in summer are in the region of 45° C. The climate, according to Köppen's classification is "tropical with summer rainfall", and according to Thornthwaite's classification "sub-humid warm, with sufficient moisture in all seasons" (Schulze, 1947).

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† Formerly known as *Hyphaene crinita*, which is apparently a tropical West African species (Furtado, 1970).

The Lala Palm Belt

The area covered by Lala Palms is shown in Fig. 1. This distribution has been plotted from aerial photographs, and ground checks in 1968 and 1969. South of St. Lucia the palm belt stops, though small isolated patches occur down the coast as far south as the Umtamvuna River.

The structure of the Lala Palm community varies quite considerably from east to west. Along the east coast the palms occur mainly as widely scattered individuals in grassland (Plate 1). The most important grass species, which form a moderately dense tussocked community up to 0,75 m tall, are *Aristida junciformis*, *Elyonurus argenteus*, *Tristachya hispida* and *Trachypogon spicatus*. The individuals of *Hyphaene natalensis* are often mixed with another palm, *Phoenix reclinata*, the Wild Date Palm, and both palms exhibit the same ability to produce several stems from a single rootstock or plant. Further inland the grassland is invaded by other woody plants and the density of *Hyphaene natalensis* increases (Plate 2), while that of the *Phoenix reclinata* decreases markedly. Some of the more common associated woody plants are *Dichrostachys cinerea*, *Acacia burkei*, *Maytenus heterophylla*, *M. senegalensis*, *Vangueria infausta*, *Sclerocarya caffra*, *Strychnos spinosa*, *S. madagascariensis*, *Combretum molle*, and *Syzygium cordatum*. In these areas bush clumps tend to form where there is some protection from fire, though woody plants are also found scattered through the grassland. These woody species vary greatly in density, height and occurrence, depending on local edaphic and biotic factors.

In those areas where the water table is near the soil surface for most of the year, herbaceous species only occur. So, although *Hyphaene natalensis* is capable of tolerating waterlogged soils, it is unable to withstand continuous waterlogging and only occurs in seasonally inundated areas.

In general then, the Palm Veld near the coast is fairly open, becoming more dense towards the Mosi Swamp where it is a mosaic of different types from open herbaceous communities to dense bush clumps.

For mapping purposes a density of at least 10 plants per acre (0,4 ha) was taken as constituting Lala Palm Veld, though nearer the coast *Phoenix reclinata* tended to confuse the air photo interpretation. Thus, Lala Palms do occur east and west of the area mapped as Lala Palm Veld, but in these areas individuals are widely scattered.

Quantitative Methods and Results

In the field Lala Palms were counted at 36 sites, each site being 70 × 70 paces, or approximately one acre (0,4 ha) in size. The location of these sample sites was governed primarily by ease of access.

Sample sites 1 to 24 were in the vicinity of the Maputa–Ingwavuma road. The first site was on the north side of the road 1,6 km from Maputa Post Office, thereafter sample sites were taken at intervals of 1,6 km on alternate sides of the road. Sample sites 25 to 29 were located on a track joining the Maputa–Ingwavuma road to the Maputa–Nseleni road, and were spaced in the same way as above. Sample sites 30 to 33 were placed 16 km from Maputa on the Maputa–Nseleni Road in the same way as above. Sample sites 34 and 35 were located on the Mbazwana–Lower Mkuzi road, and site 36 on the main road south of Hluhluwe (see Fig. 1).

At each sample site the number of individual plants of *Hyphaene natalensis* was counted and the number of stems per plant recorded. The number of leaves per stem was also counted. These data are summarized in Table 1.

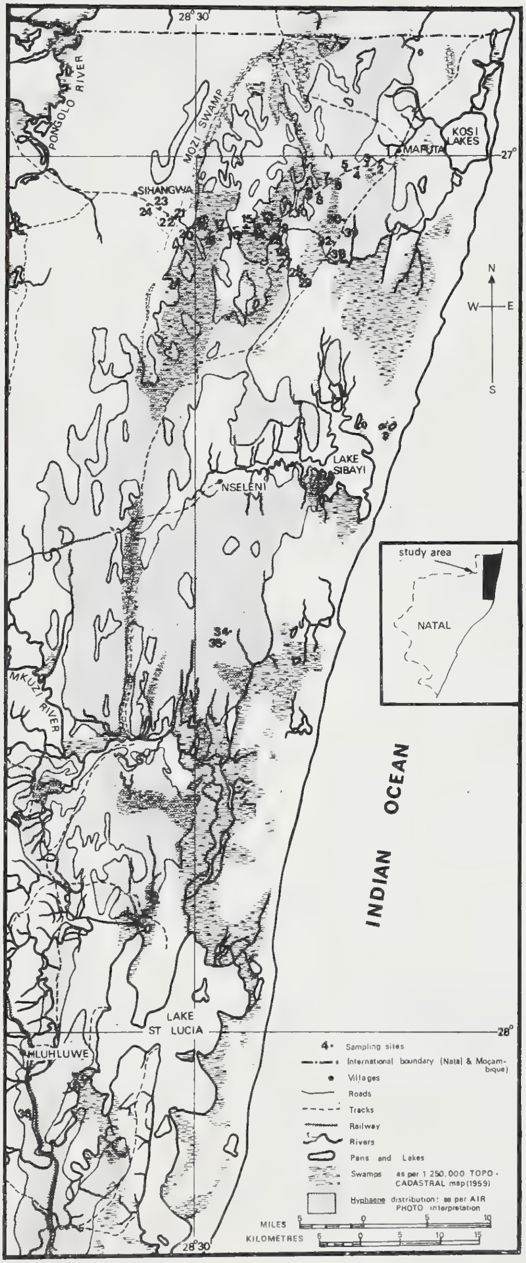

Fig. 1.—Map of eastern Tongaland showing the distribution of **Hyphaene natalensis,** swampy ground, and coastal lakes in the study area.

TABLE 1.—Summarized field data of the number of plants, stems and leaves of *Hyphaene natalensis* counted in 36 one-acre (70 × 70 paces) (0,4 ha) sample sites.

Sample sites	Total No. of plants per acre (0,4 ha)	Total No. of stems per acre (0,4 ha)	Average No. of stems per plant	Total No. of leaves per acre (0,4 ha)	Average No. of leaves per plant	Average No. of leaves per stem
1*	1	1	1,00	1	1,00	1,00
2	7	12	1,71	45	5,00	3,75
3	10	50	5,00	185	18,50	3,70
4	17	17	1,00	63	3,71	3,71
5	11	16	1,45	35	3,18	2,19
6	11	18	1,64	39	3,55	2,06
7	34	115	3,38	426	12,35	3,70
8	15	37	2,47	76	5,07	2,06
9	13	21	1,62	41	3,15	1,95
10	11	18	1,62	29	2,62	1,61
11	69	168	2,44	711	10,30	4,24
12	33	91	1,32	398	12,07	4,35
13	64	454	7,10	891	14,02	1,97
14	71	246	3,47	687	9,68	2,39
15*	7	25	3,57	157	22,43	6,28
16*	9	19	2,11	96	10,68	5,05
17	109	1 289	11,74	1 904	17,47	1,48
18	179	1 789	9,99	2 674	14,94	4,50
19	17	43	2,52	131	7,71	3,05
20*	2	3	1,50	12	6,00	4,00
21*	1	1	1,00	4	4,00	4,00
22*	3	7	2,33	26	8,67	3,71
23*	1	1	1,00	5	5,00	5,00
24*	1	2	2,00	6	6,00	3,00
25	33	103	3,43	317	9,60	3,08
26	5	9	1,80	24	4,80	2,64
27	11	21	1,18	58	5,27	2,76
28*	1	1	1,00	3	3,00	3,00
29*	1	1	1,00	3	3,00	3,00
30	15	23	1,53	65	4,33	2,83
31	17	31	1,82	74	4,35	2,39
32	14	25	1,64	65	4,64	2,60
33	12	21	1,75	37	3,08	1,76
34	83	182	2,19	772	9,30	4,24
35	71	147	2,04	689	9,70	4,69
36	30	144	4,80	668	22,27	4,64

* Sample sites outside the area mapped as *Hyphaene* Palm Veld.

The area of Lala Palm Veld in Tongaland and Northern Zululand is approximately 156 000 ha (600 square miles, about 375 000 acres). From the field data obtained from sites within the area mapped as *Hyphaene* Palm Veld, excluding data from the 10 sample sites outside the mapped area, we find the following:

Average number of plants per acre (0,4 ha) = 37,00

Average number of stems per acre (0,4 ha) = 195,77

Average number of stems per plant = 5,28

Average number of leaves per acre (0,4 ha) = 427,08

Average number of leaves per plant = 11,25

Average number of leaves per stem = 2,18

The total number of individual *Hyphaene* Palms may be estimated as 14 000 000 individuals, comprising approximately 73 500 000 stems and bearing a total number of about 160 000 000 leaves. However, from the data in Table 1 it is apparent that the figures have been affected by the two sample sites, 17 and 18. From field experience and from a close study of the air photographs, it is clear that areas where *Hyphaene natalensis* is dense are extremely limited, and have been estimated at less than 5%. A more realistic estimate of the total number of individual Lala Palms is, therefore, about 10 500 000 individuals comprising approximately 31 000 000 stems and bearing a total number of about 100 000 000 leaves. It should be noted that owing to utilization by the local Bantu (see later) the average number of leaves per plant is probably considerably lower than normal (compare Plate 4).

Proposed Utilization of Lala Palm

As already stated, it has been suggested that the Lala Palm be commercially exploited for its fibre. With the statistics obtained, the economics of the scheme can be more readily assessed.

Each leaf of *H. natalensis* has a life span of two to three years. From the data presented above it is apparent that on average each stem produces only one new leaf a year. This means that at most one stem will yield, on a sustained yield basis so as not to decimate the population, one leaf in three years. Therefore, the annual yield of leaves from the entire area could be in the region of 33 000 000 leaves. This may, on superficial examination, appear an economic proposition. However, it must be remembered that communications in this region are extremely poor and that the area involved is relatively large, being about 160 km long and 32 km wide.

In addition to these factors, ownership of the land and of the Lala Palms themselves poses a problem. Some of the land is Bantu Area, some of it is White farmland, but most of it is State owned and occupied by Bantu. Also, it is not clear at this stage how well the plants, which grow extremely slowly at a rate of about 0,5 m in 10 years, will tolerate defoliation, as the leaves required for fibre production are the young leaves, not the old leaves.

On the credit side, it must be said that it is the practice of the Bantu to top selected stems and collect the sap (Plate 3). This topping seems to have little effect on the plant which merely produces another stem from the rootstock, the stem which is topped dying off. This practice, coupled with frequent burning of the grassland, has stunted the growth of the Lala Palm in Tongaland which, if protected, is capable of growing into an attractive tree five to eight metres high (Plate 4).

Current Utilization of Lala Palm

Lala Palms have two major uses for the local Bantu in Tongaland.

1. The leaves are used in all forms of basket work.

2. The sap of the palm is tapped, and the sap is collected and allowed to ferment into a potent brew, locally called *ubuSulu*. This *ubuSulu* is an essential ingredient of their diet as it produces yeast cells and also the essential vitamin B, riboflavine and nicotinic acid (Campbell, 1969). In addition, quantities of this *ubuSulu* are "exported" to the surrounding regions where it is sold (Moll, 1968). This traditional practice injects money into an otherwise extremely poor economy and one week's work earns one man sufficient money for one month's existence. Over the years, ownership of the palms has been established and these rights are jealously protected. Poachers are harshly dealt with and are lucky to escape with their lives.

The decision to allow or prohibit exploitation of the Lala Palm for fibre is one which cannot be taken easily. All facts and traditional customs must be considered before the final step is taken.

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PLATE 1.—A general view of the typical coastal phase of the Palm Veld between Maputa and Lake Sibayi: **Hyphaene natalensis** in the foreground, a group of **Phoenix reclinata** in the left middle distance, and scattered **Syzygium cordatum** trees.

PLATE 2.—A general view of the typical inland phase of the Palm Veld about 80 km north of Nseleni, with fairly dense clumps of **Hyphaene natalensis** and scattered trees and bushes, an open wet grassland patch, and dense woodland.

PLATE 3.—A typical tapped **Hyphaene natalensis** showing the protective "hat" woven from a single leaf, the sliced stem and clay collecting vessel.

PLATE 4.—An example of **Hyphaene natalensis** in the grounds of the Natal Herbarium, Durban This 3-stemmed individual was planted in the early 1900's.

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Notes on the Vegetation of the Cape Flats

by

H. C. Taylor*

Abstract

Though the Cape Flats, adjoining Cape Town, were among the first explored parts of South Africa, their vegetation, rapidly being altered by encroachment of alien plants, has not been described before. In these notes, five inland and four coastal plant communities, delineated by habitat, are described; their relationships with one another and with coast-flats vegetation elsewhere are suggested. Observations on means of regeneration after fire show that the woody, tropical-derived element regenerates rapidly from coppice, while the "fynbos" or temperate sclerophyll element contains many seed-regenerating species. Succession in the fynbos is thus more complex and prolonged.

Introduction

Very little has been written on the vegetation of the Cape Flats. Acocks (1953) described it in broadest outline as Coastal Macchia (Veld Type 47). Stephens (1929) described the vegetation of specialized aquatic habitats and Adamson (1959) has discussed the phytogeography of the area. The vegetation of Robben Island (Adamson, 1934) has features in common with the coastal areas of the Cape Flats, but it is impoverished in species and highly modified by rabbit-grazing. The Stellenbosch Flats, treated in detail by Duthie (1929), are alluvial in origin, the soil clayey and the vegetation quite different from that on the sandy dunes of the Cape Flats.

The present notes were made in conjunction with observations on veldburning regeneration.

Physical Features

The Cape Flats, some 400 square km (150 square miles) in extent, form a broad, sandy isthmus connecting the Cape Peninsula to the mainland. They are bounded on the west by the mountains of the Cape Peninsula, on the north and north-east by the Tygerberg and Bottelary Hills, eastward by the Eerste River and southward by the False Bay coast. The western and northern portions already form part of Greater Cape Town and building activity is steadily encroaching eastward.

A sea-strait formerly separated the mainland from the present peninsula. Most of the area which now forms the Cape Flats was submerged until the coastal elevation of 27 m occurred (Taljaard, 1949) about 175,000 years ago (Walker, 1952). The Cape Flats are composed mainly of sand with inter-layered clay bands. The sand extends to depths of over 30 m below the surface and rests on an uneven foundation of Malmesbury rocks and granite. These surface materials were mainly deposited as beach drifts, subsequently added to by wind action. The Flats have a dune topography with a belt of foredunes fronting the shore and long sand ridges extending inland in the direction of the prevaling south-easterly wind. The dunes are of varying age, those towards Muizenberg being younger and lower. Average elevation is roughly 34 m and maximum elevation 60 m.

Alien Vegetation

By 1850 the encroachment of sand threatened the first hard road across the Flats. To bind the drift the Colonial Secretary, the Hon. John Montagu, "imported Port Jackson trees and Australian Myrtle, which were planted along with hakea" (Mossop, 1927). This work was greatly extended by the newly-created Forest Department after

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J. Storr Lister was appointed Superintendent of Plantations in 1875 or 1876 (Roux, 1961). The most successful species were the two Australian wattles, *Acacia cyanophylla* (Port Jackson) and *A. cyclops* (Rooikrans). These two sand-binders have now spread by natural means, not only over most of the Flats, but also in favourable habitats along the north and east coasts as far as Olifants River and Port Elizabeth, respectively.

The reclamation of the dunes is complete but dense thickets of wattles are rapidly ousting the last vestiges of indigenous vegetation. *Acacia cyclops* is the more widespread of the two species, spreading rapidly from seed carried by birds (especially the Redwing and Pied Starlings) and regenerating with vigour after a fire. Where both wattles occur together, *Acacia cyanophylla* may become dominant in frequently burnt areas, because it coppices from the base of the trunk immediately after a fire, whereas *A. cyclops* is killed outright and must regenerate more slowly from seed. Both wattles, but especially *A. cyclops*, are culled for firewood on reaching a basal diameter of 10–13 cm.

Besides the ubiquitous Acacias, I found *Callitris robusta* (Australian Cypress Pine) regenerating profusely after a fire. At present I know of only one small patch of about 0,2 ha near the Hollandia Flying Club. Because of its abundant regeneration this species may eventually suppress any remaining patches of indigenous vegetation on the Cape Flats.

Eucalyptus gomphocephala, a species widely planted as a windbreak and avenue on the Cape Flats, is also spreading in old veld to a distance of 180 m from its parent trees. Its spread is limited compared with the other species mentioned.

Indigenous Vegetation

Parts of the Eerste River Forest Reserve along the N2 National Road, especially an area of some 200 hectare near the Cape-Stellenbosch Divisional Boundary, are only lightly invaded by alien plants. Here it is still possible to determine the structure, composition and relationships of indigenous vegetation some 6,5 km inland. Nearer the coast, notably on Strandfontein Coast Forest Reserve, large stretches of indigenous vegetation are still intact, though the ill-advised practice of stabilizing the sandy cuttings of the new coast road with *Acacia cyclops* will soon alter this.

In this account the inland and coast vegetation are described and compared. The field work was done in late summer (February) when many of the plants were not in flower and when few annuals or geophytes could be recognized. This description is, therefore, general and preliminary.

Inland Communities

These communities (except the Fynbos of Reddish Sands) occur on the Eerste River Forest Reserve north of the National Road near the Cape-Stellenbosch Divisional boundary. The soil here consists of fine white sand, riddled with mole holes and littered with snail shells 1–2 cm in diameter. The gently undulating topography is broken by long narrow ridges about 12 m high. These are the original wind-formed dunes running parallel to the prevailing south-easterly winds. Low lying depressions, swampy in winter, have a different vegetation.

On the higher ground of the undulations and ridges are *Euclea-Rhus* and *Metalasia* communities.

(1) *Euclea-Rhus* Inland Dune Scrub occupies chiefly the ridge crests, but in old veld extends to the undulations between crests as well. Typical woody species are *Euclea racemosa*, a frequent dominant; *Rhus lucida*, a fairly frequent co-dominant; and *Rhus glauca*, which is less frequent. *Rhus crenata* and *Olea exasperata* are both rare and local, the latter indicating a degree of development towards a taller bush community.

The Dune Scrub is characteristically dense, 2–3 m tall, consisting of few species in constant association and with no understorey. A few climbers are also found. This vegetation is allied to and probably derived from the subtropical forest flora and is quite distinct in physiognomy and floristics from the "fynbos", which is the local term for the macchia or sclerophyll vegetation typical of the South-western Cape Province.

(2) *Metalasia* Inland Dune Fynbos, typically about 1 m tall, covers most of the undulating country. Its composition is complex and varies strikingly within short distances, with no obvious change in site conditions. In some places the dominant shrubs are *Passerina* spp.—*Zygophyllum fulvum*—*Mundia spinosa*, at others *Stoebe plumosa*—*Cliffortia falcata*—*Diosma hirsuta*, and at yet others *Metalasia muricata*—*Passerina*. These probably represent different stages in the succession after fire. The oldest fynbos so far seen, which is 1–2 m high, has the highest proportion of *Metalasia muricata* and tentatively the succession after fire may be *Stoebe plumosa* ⩾ *Passerina* spp. ⩾ *Metalasia muricata*. *Stoebe plumosa*, being a coppicing species, regenerates rapidly after fire and soon dominates the bare areas, whereas *Passerina* spp. and *Metalasia muricata*, which regenerate solely from seed, become dominant at a later stage. Besides the mere fact of burning, however, the season and cycle of burns also help to determine which course the succession will follow.

Because the dominants are so varied, a search was made for species which, though not necessarily dominant or even striking, are confined to this community and can therefore be regarded as character species. Two of these are *Psoralea fruticans*, a virgate legume, and the grass *Ehrharta villosa* (Pypgras). Both are scattered throughout all variations of the Dune Fynbos, even towards the coast and on the limestone formation at Strandfontein where the species composition is rather different. In the sandy openings characteristic of fynbos, *Ehrharta villosa* is, indeed, often dominant, and geophytes and annuals are also common.

A species characteristic of the Dune Fynbos, though not faithful to it, is the woody shrub *Rhus mucronata*. It occurs in almost pure spreading stands of 20–84 m^2 and 0,6–1 m high, which probably consist of a single individual with a spreading underground rootstock. On the coastal limestone at Strandfontein this species is replaced by *Rhus glauca*. In better developed Dune Fynbos the woody shrub *Myrica quercifolia* commonly occurs as an understorey 30–60 cm high. It spreads in much the same way as *Rhus mucronata* except that it does not occur in pure stands.

The inland depressions bear a different vegetation.

(3) In the low-lying parts, inundated in winter, there is a **Grass-Rush community** in which the families Gramineae, Cyperaceae, Restionaceae and Juncaceae show marked, local, single-species dominance. These dominants are *Imperata cylindrica*, *Scirpus nodosus*, *Chondropetalum tectorum* and *Juncus kraussii*, all with dense masses of rhizomes matted together just below the soil surface. Perhaps partly because of this, and partly because of the poor drainage, the alien wattles are much less frequent in these depressions than in the well-drained sands of the higher ground.

Associated with the grass-rush mixture are bushes, mainly Composites, such as *Senecio halimifolius*, *S. angustifolius*, *Nidorella foetida* and *Othonna parviflora*. Occasionally in open areas the two creeping grasses, *Cynodon dactylon* and *Stenotaphrum secundatum*, are found.

(4) Within the low-lying areas occur small mounds raised about 1,3 m above the general surface. These mounds bear an Inland Dwarf Fynbos quite different to the grass-and-rush of the hollows. It is distinguished from Dune Fynbos by (i) its dwarf character, the plants seldom being over 60 cm tall, usually 30 cm; and (ii) the occurrence of almost pure stands with a single dominant. Here again, however, the actual

dominants vary from place to place, the chief being *Passerina* spp., *Aspalathus hispida* and *Muraltia mitior*. These species are all found within the Dune Fynbos, but not as single dominants nor in this dwarf form.

The mounds may have been formed by the accrual of windblown sand against obstacles such as bushes of the grass-rush community, and if built up further, typical Dune Fynbos would probably result. The occurrence of stunted plants of *Metalasia muricata* on some of the higher mounds lends support to this view, as does the presence of the two character species *Psoralea fruticans* (dwarf form) and *Ehrharta villosa*.

(5) *Thamnochortus—Passerina* Fynbos of Reddish sands.

Near the Nuclear Research Institute, where the old National Road is bordered to the south by a line of Eucalypts, is an area of level, well-drained, reddish, fine-textured sand. This sand is commonly found towards the eastern end of the Cape Flats and probably owes its distinctive character to an overlay of detritus from the sedimentary and igneous rocks of the Faure hills. The veld has been very heavily invaded by wattles but a few small patches of indigenous vegetation remain.

The vegetation is similar to parts of the Bredasdorp Strandveld, for example near Uilenkraal. It is two-layered, with an upper discontinuous layer of *Thamnochortus erectus* and *Passerina vulgaris* in scattered clumps, both species about 1,3 m high. In the denser lower layer, 30–60 cm high, *Aspalathus hispida* is common and succulents, such as the creeping *Carpobrotus acinaciformis* (Sour Fig) and *Crassula cymosa*, are associated. Openings, sometimes 25 m^2 in area, are covered with annuals in spring (*Dimorphotheca*, *Dorotheanthus*, *Ursinia* etc.) but are bare at other seasons except for pioneer clumps of *Cynodon dactylon*.

The two character species of Dune Fynbos, *Psoralea fruticans* and *Ehrharta villosa*, and clumps of *Rhus mucronata*, are found, showing a close relationship between these two communities. On the other hand, the family Proteaceae, virtually absent from the Dune Fynbos, is here represented by *Leucadendron levisanum* in the upper layer and *Serruria* sp. in the lower layer, showing an affinity with the Bredasdorp Strandveld where the family is well represented, especially by *Leucadendron* spp.

Coastal Communities

The strand topography is somewhat similar to the alternating dunes and flats found inland, but the dunes are higher and more evenly spaced with the intervening flats being merely troughs or slacks separating one dune from another. Poorly-drained depressions are found only behind the foredune at the coast. Limestone beds covered by a thin layer of fine calcareous soil are a distinctive feature of this coast environment.

The plant communities of the coast follow the same pattern as those found inland but differ in detail.

(1) *Pterocelastrus* Coast Dune Scrub. *Euclea racemosa* is not as common as further inland, its place as dominant being taken by *Pterocelastrus tricuspidatus* (Kershout). The morphological variation of this species is remarkable. In the Knysna forests it is found "as a large tree, 60 ft to 80 ft in height by 6 ft or 7 ft g.b.h. . . . throughout the forests but is more frequent in the drier than in the moister forests" (Laughton, 1937). Along the coast it occurs quite frequently as a bushy shrub about 2 m high, from the Knysna area right round the south coast to the vicinity of Lambert's Bay.

Floristic features which distinguish Coast Dune Scrub from its inland counterpart are: (i) the virtual absence of *Rhus lucida*, its place being taken by *Rhus glauca*; and (ii) the occurrence of the coastal woody shrub, *Cassine maritima*. In physiognomy, Coast Dune Scrub is lower (1–2 m) with a "wind-sheared" appearance, the tender growing tips being constantly arrested by salt-laden winds from the ocean. It is

more or less evenly spaced in a mosaic of oblong patches, particularly along the foot of the dunes and not on the crests. Where well-developed, these patches coalesce into an almost continuous belt. *Salvia aurea* is associated with the woody element and the climbers *Cynanchum obtusifolium* and *Kedrostis nana* occur.

(2) *Metalasia* Coast Dune Fynbos extends inland about 1,6 km from the coast. Here the fynbos is very similar to the inland community except for the presence of *Myrica cordifolia*, a typical coast species, and in openings a greater proportion of succulents such as *Mesembryanthemae* and *Euphorbia caput-medusae*. Mixed dominance is still apparent. Nearer the coast, however, just behind the littoral dune, *Metalasia muricata* occurs in almost pure stands over large areas.

On the littoral dune itself many succulent and semi-succulent plants appear, such as *Senecio elegans* (which, though an annual, has a succulent form near the coast), *Arctotheca nivea*, *Hebenstreitia cordata*, *Cnidium suffruticosum*, *Tetragonia fruticosa*, *Carpobrotus acinaciformis* and other *Mesembryanthemae*. Marram grass (*Ammophila arenaria*) has been planted to stabilize open sand on the littoral dune. When drift has been stopped in this way, Marram becomes moribund and shrubs like *Metalasia muricata* and *Passerina ericoides*, another typical coast plant, invade the stabilized dune.

(3) The vegetation of depressions near the coast is more mixed than that of inland depressions, with little single-species dominance. Chief plants found on these sites where the salt content of the soil is high, are *Scirpus nodosus*, *Plantago carnosa*, *Sporobolus virginicus*, *Chironia decumbens*, *Cnidium suffruticosum*. *Helichrysum orbiculare*, dominant in areas with less salt in the soil, represents a distinct community or sere.

(4) Coast Dwarf Fynbos of the Limestone Formation. Limestone occurs quite extensively near the coast. It bears a dwarf fynbos which includes many inland species plus a few others, but in different proportions. None of the shrubs are over 30 cm tall, usually less. *Rhus glauca* replaces *R. mucronata* of the inland veld, forming patches only about 20 cm tall by roughly 3 m^2 in area.

Acocks (1953) regards dwarf fynbos on limestone in the Bredasdorp Division as a distinct veld type; this seems to be true also of limestone vegetation on the Cape Flats. It needs more detailed study.

Regeneration after fire

Wicht (1945) recognizes four ways in which Cape plants can survive fire: regrowth from soil storage organs (geophytes), regeneration from seed, sprouting from rootstocks, and growth from dormant buds when the stems and branches are so well insulated against the heat of fire that they are not normally killed.

An examination of Cape Flats vegetation about three months after it was burnt in the summer of 1961–62 showed the following species in these four categories:
(1) Geophytes: *Brunsvigia orientalis* flowering; the first geophyte to be recognized. Others were pushing their leaves above ground, but the majority would only come up after the first rains.

(2) Regeneration from seed: The following burnt plants which showed no sprouting three month after the fire may be regarded as seed-regenerating species: *Passerina vulgaris*, *Phylica ericoides*, *Mundia spinosa*, *Metalasia muricata*, *Acacia cyclops*. Many fynbos species, especially the dominants of the older stages (*Passerina* and *Metalasia*) fall into this category.

(3) Sprouting from rootstocks: *Aspalathus hispida*, all *Asparagus* spp., *Antizoma capensis*, *Chrysanthemoides monilifera*, *Cynanchum obtusifolium*, *Cymbopogon marginatus*, *Diosma hirsuta*, *Euclea racemosa*, *Hermannia* sp., *Imperata cylindrica*, *Myrica quercifolia*, *Psoralea fruticans*, Restionaceae, *Rhus crenata*, *R. lucida*, *R. mucronata*,

Salvia aurea, *Stoebe plumosa*, *Zygophyllum fulvum* and two unidentified grasses. *Imperata* and an *Asparagus* were already flowering and fruiting. Length of sprouts varied from 2,5 cm (*Antizoma*) to 100 cm (*Asparagus*), but most shrubs showed an average growth of about 30 cm. At this short interval after fire, regeneration is mainly from sprouts. Of the 18 regenerating species recorded in four 0,025 ha (0,01 acre) transects, only one unidentified geophyte was not a root-sprouting species (Table 1).

The occurrence of *Stoebe plumosa* in the above list supports the view that *Stoebe*-dominated fynbos is younger than that dominated by *Passerina* or *Metalasia*. The list shows that most components of Woody Scrub regenerate from sprouts. *Rhus glauca*, not found sprouting, may be slower than the others and is unlikely to fall in any of the other categories.

(4) Growth from dormant buds: On the edge of the burn where the bushes were only singed, *Psoralea fruticans*, *Rhus crenata* and *Rhus glauca* sprouted from stem-buds but the above-ground portions would have been completely killed in a severe fire.

Observations and Conclusions

(1) In the early stages, sprouting from rootstocks and from the base of the stem is the commonest means of regeneration after fire. Coppicing species are especially common in the scrub and the grass-rush communities. Fynbos contains a few coppicing species in the early stages but later regeneration is from seed. The alien *Acacia cyclops* is a seed-regenerating species. Because of these facts (a) the scrubby dune-crests and the grassy hollows are revegetated before the intervening slopes and undulations where fynbos predominates; (b) the succession in Dune Scrub is simple and comparatively rapid whereas succession in fynbos is more complex and prolonged; (c) the indigenous vegetation regenerates quicker than does the alien *Acacia cyclops*; however, burnt dunes previously fixed by *Acacia cyclops* contain more leaf-mould and matted roots which bind them better than the indigenous species.

(2) In both burnt and unburnt fynbos *Psoralea fruticans* is the only species which can withstand severe competition from *Acacia cyclops*. This tolerance, and its vigorous sprouting, may explain its constant occurrence as a character species in the many variations of fynbos vegetation found on the Cape Flats.

TABLE 1.—Density of regeneration three months after fire in Inland Communities [transects 12 × 3,4 m (39,6 × 11 ft)]

Species	No. of plants		
	Transect 1	Transect 2	% Total number
(a) Grassy Flats			
Grasses (mainly *Cymbopogon, Imperata*)	69	177	54,1
Myrica quercifolia	74	98	38,0
Stoebe plumosa	12	—	2,6
Rhus mucronata	9	1	2,2
Restionaceae	6	—	1,4
Geophytes	4	—	1,0
Zygophyllum fulvum	3	—	0,7
	177	276	100,0

TABLE 1 *(continued)*

Species	No. of plants		
	Transect 3	Transect 4	% Total number
(b) Dune Slope			
Euclea racemosa (ridge)	53	51	35,3
Myrica quercifolia (lower slopes)	27	37	21,8
Rhus mucronata (lower slopes)	7	32	13,3
Grasses	4	9	4,4
Restionaceae	1	11	4,1
Salvia aurea	5	5	3,4
Cynanchum obtusifolium	1	8	3,1
Rhus lucida	3	6	3,1
Psoralea fruticans	6	2	2,7
Cyperaceae	6	1	2,4
Chrysanthemoides monilifera	1	5	2,0
Geophytes	2	2	1,4
Stoebe plumosa	—	3	1,0
Antizoma capensis	1	1	0,7
Diosma hirsuta	2	—	0,7
Aspalathus hispida	1	—	0,3
Asparagus spp	1	—	0,3
	121	173	100,0

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PLATE 1.—Bare appearance of the undulating country of the Eerste River Forest Reserve on the Cape Flats, three months after fire.

PLATE 2.—Similar area as in Plate 1 several years after fire showing *Acacia cyanophylla* and a few *A. cyclops* (exotic species) in hollow with scrub, including *Rhus lucida*, on ridges.

PLATE 3.—Dune scrub, mainly *Euclea racemosa*, with low *Rhus mucronata* colony in foreground.

PLATE 4.—Crest of burnt ridge vegetation showing abundant coppice regeneration of *Euclea racemosa*.

PLATE 5.—Example of regeneration after fire from underground storage organs by *Brunsvigia orientalis*. Note young plant emerging from soil at left.

PLATE 6.—Prolific regeneration after fire from seed by exotic species, *Callitris robusta*, with *Acacia cyanophylla* and *A. cyclops* in background on right.

Book Reviews

THE EVERGREEN FORESTS OF MALAWI BY J. D. CHAPMAN AND F. WHITE, 190 pp. Commonwealth Forestry Institute, University of Oxford 1970. Price £3.

The extreme importance of this publication is emphasized by a comment of the junior author, "Malawi is situated more or less midway along the great chain of mountains and upland areas which extends with intervals from the Ethiopian highlands to South Africa. The forests are, therefore, of considerable phytogeographical as well as ecological interest." Many northern species reach the southern limits of their range and southern species reach their northern limits in Malawi.

For various reasons, not the least of which being the enthusiasm and diligence of Mr. Chapman, the forest flora of Malawi is comparatively well known although, as White points out, further exploration of the few patches of forest still surviving in more inaccessible terrain will undoubtedly add new species to the very comprehensive lists available for the territory.

There is some urgency for studies of this nature elsewhere in tropical Africa. As the reviewer has suggested on more than one occasion (Kerfoot, 1961, 1964, 1968), montane, submontane and fringing forest are perhaps the most vulnerable of all vegetation types to indiscriminate land use by the ever-increasing African populations, and already much valuable scientific information has been irrevocably lost as a result of forests being completely cleared before botanists have had a chance to investigate them. There is a note of warning here for South African botanists too—those extensive fragments in the eastern Transkei and Pondoland, painted in glowing colours by Henkel at the turn of the century (Henkel, 1903), are still largely unknown and they are shrinking fast.

With the advent of this publication, at least we can now claim some authority to speak confidently of the evergreen forests of Malawi.

The work is divided into two parts. Part I includes environmental features, phytogeographical relationships, the classification of types and of course, taxonomic relationships. In Part II, the individual forests of Malawi are described in relation to their local environments. There are seven good profile diagrams (although the scale on one is partially inverted) and detailed soil descriptions and analyses.

There are sixty black and white plates and a reference list which is comprehensive enough for Malawi, but inadequate for the remainder of the "great chain of mountains and upland areas". At the price, a most valuable production, although the flimsiness of the binding is not conducive to its long-term survival.

The recurrent emphasis is on the interdependence of ecology, phytogeography and taxonomy. How often is this ignored in Botany Schools to the detriment of the students concerned! Intensive studies of limited areas of Africa are likely to be more rewarding in the long run than attempts to cover phytogeographical territories *in toto*, attempts which will inevitably be imprecise and frequently downright misleading. For example, some of the gaps in distribution of elements included in this survey are wholly erroneous, confirming Hedberg's contention that many published discontinuities in the African flora are a result of either incomplete collecting or faulty recording.

There are errors in this book, but few so vital as to detract from the reliability of data in Part II. The authors do not seem to have made up their minds in the text as to whether *Trema orientalis* is *orientalis* or its synonym *guineensis*, although in Appendix 2, Polhill's taxonomic treatment is given. The same sort of thing applies to *Prunus* (*Pygeum*). *Acacia campylacantha* is now *A. polyacantha* ssp. *campylacantha*.

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One or two authors are cited in the text, but not reflected in the bibliography (Walter, 1964 for example). There is discrepancy as to who is the senior author, Phipps or Goodier, of the Chimanimani paper and for good measure they are duplicated in the bibliography. Surely it would have been better to cite Fosberg's treatment of vegetation for IBP, rather than his earlier (1961) classification?

There is some contradiction in the content of pages 32, 34 and 89. Few botanists in South Africa would agree with White's view that *Calodendrum* is endemic to the Oriental Domain, neither would they confirm his opinion of the distribution of *Cryptocarya*. The reviewer is not altogether in agreement with the allocation of some species to certain phytogeographic elements, as he is aware of their occurrence in regions and domains other than those given here. There is, in fact, a pontifical aura in the phytogeographical section between pages 53 and 72 which is rather disconcerting and accords ill with the author's own words, "...so much remains to be discovered about the geography of African plants...".

But this is the kind of publication we must have if the origin, distribution and phytogeographic relationships of elements of the African flora are to be fully understood, and if classifications are to be constructed which have any ecological validity. One can look forward with the sheerest enjoyment to their companion volume 'The Forest Trees and Shrubs of Malawi' if it maintains this standard.

O. Kerfoot

Flora of Lesotho by Amy Jacot Guillarmod. Lehre: J. Cramer. 1971. Pp. 474, 1 map. Price DM 120.

This is the long-awaited Flora of Lesotho—not really a flora in the modern sense of the word, since it contains no keys or descriptions of plants, but rather a check list with supplementary data on the history, environment, vegetation and flora of Lesotho.

Dr. Amy Jacot Guillarmod, presently senior lecturer in botany at Rhodes University in Grahamstown, lived for many years in Lesotho and has done much collecting in that country. She is therefore well qualified to write about the flora of Lesotho. This work represents a D.Sc. thesis presented at the University of St. Andrews, Scotland.

The book starts off with a brief history of Lesotho from the late 18th Century, through the long reign of Moshoeshoe, to 1966 when Lesotho achieved independence as a self-governing country within the British Commonwealth. Next, the topography and geology of the country are described. The country is divided into three altitudinal zones, namely lowlands, foothills and mountains, which correspond with the three main vegetation zones. The description of the climate is necessarily brief, because there are so few meteorological stations in Lesotho. Land tenure is discussed and it is shown how important this is in relation to land use. Dr. Jacot Guillarmod states that the indigenous vegetation is under extreme pressure from the population, both human and animal, in spite of the rather difficult terrain of the country. Many species are well on their way to extinction, the character of the vegetation is changing rapidly, especially in the mountain pastures and many new weeds have entered the country in the last 50–60 years.

The account of the ecology of Lesotho is somewhat superficial with relatively few species being mentioned but, as Dr. Jacot Guillarmod points out, the work was not meant to be an ecological investigation. As a supplement to the ecological contributions of Phillips (1917) and Staples and Hudson (1938), the account is useful.

The flora is analysed, there being 485 monocotyledons and 1 052 dicotyledons giving a total of 1 537 species. It may seem surprising that Phillips recorded an even higher number, 1 553 species, but he included some species which occur outside the boundary of Lesotho. The chief discrepancy between the family analyses of Jacot Guillarmod and Phillips is the higher position occupied by the family Scrophulariaceae in the former—third place (7,8%) as against sixth place (5,4%). The total of 1 537 species for Lesotho seems very low and it is reasonable to assume that with further collecting, particularly in the high mountain areas and the southern part of the country, this figure will be much exceeded.

Biographical notes are given on many of the plant collectors in Lesotho, most information naturally being given about Madame Anna Dieterlen, the doyen of collectors in Lesotho, who collected some 1 380 numbers (possibly over 2 000 according to Dr. Jacot Guillarmod). There is one omission in the list of collectors, namely Mann who collected at Mont aux Sources. Thode is credited with collecting "a few specimens on the summit of Mont aux Sources in February 1891". In fact, Thode collected on the summit of the Drakensberg on numerous occasions between 1891 and 1914. There are 6 309 of Thode's specimens in the Stellenbosch Herbarium, a collection described by Pole Evans as the "cream of Thode's collection—his high mountain specimens". There are undoubtedly many specimens from Lesotho in this collection. Thode even penetrated quite far into Lesotho: in a letter to Bolus (5/2/1896) he describes an unfortunate collecting expedition to the Maluti mountains when he was prevented from going any further by Chief Jonathon, son of Molappo, because he was suspected of being a prospector.

Immediately preceding the check list is a locality index—a most useful aid for anyone working on the flora of Lesotho. Dr. Jacot Guillarmod has listed all the locality names she has found on specimens from Lesotho, and for each has given the modern spelling, district, and latitude and longitude. Even vague localities such as "barren, boggy wastes" are given precise map references.

The check list consists of 230 pages. The families and genera of flowering plants are arranged according to De Dalla Torre and Harms, while species are arranged alphabetically. Under each species the specimens seen by Dr. Jacot Guillarmod are cited together with the herbaria where they are located. Most of the specimens were identified at the National Herbarium, Pretoria. On p. 116 it is stated that the grass, *Polevansia rigida*, is endemic to Lesotho. However, since the book went to press the grass has been collected near Lady Frere in the eastern Cape.

A Sotho glossary is provided giving firstly the plant names with the Sotho equivalent and then vice versa. This glossary has obviously involved a tremendous amount of research.

The book concludes with a section on the uses of plants. It is quite astonishing to see how many plants have a known use, whether it be for food, medicine, witchcraft, charms, household purposes, the making of implements, building, decoration or amusement.

This book is a most valuable contribution to our knowledge of the flora of Lesotho and will serve as a basis for future botanical investigations in that country. The author and publisher are to be congratulated on the production of an excellent book.

D. J. B. Killick

THE GENERA of the MESEMBRYANTHEMACEAE by H. HERRE. *Cape Town*: *Tafelberg-Uitgewers Beperk*, 1971. *Pp.* 316, 124 *colour plates. Price* R21,00.

This book is a most welcome contribution to the literature of South African botany. It deals with a predominantly South African group of succulent plants which have been a source of continuous botanical interest since the middle of the 18th century. The plants have been in the lime-light with growers of succulent plants throughout the world for very many years.

Prior to 1925 when N. E. Brown, at the Royal Botanic Gardens, Kew, began the intensive study of the group, almost all the many species were classified under the genus *Mesembryanthemum*. Brown found good reason for subdividing this genus into smaller units. It may or may not be regarded as a misfortune to botany that several eminent botanists followed the lead given by Brown, notably Schwantes in Germany and L. Bolus in South Africa, to give generic rank to splinter groups or individual species of the old genus *Mesembryanthemum*. There was more competition than co-operation between these botanists with the inevitable result of confusion and the creation of much avoidable synonymy.

Hans Herre came to South Africa from Germany in 1925 to become the first curator of the University of Stellenbosch Botanical Garden under Prof. G. C. Nel. He specialized in succulent plants from the beginning. He maintained contact with his overseas colleagues including Alwin Berger, G. Schwantes and Herman Jacobsen, in South West Africa with Kurt Dinter and in South Africa with Louisa Bolus. He thus occupied a unique position in the botanical turmoil of *Mesembryanthemum* and accumulated a vast practical knowledge of this fascinating group of plants.

With the death of all but Dr. Jacobsen of his older colleagues, it was natural that Hans Herre should wish to co-ordinate their work in one comprehensive volume. This he has done admirably with the close co-operation of several younger colleagues and the invaluable help of the Bolus Herbarium, within the University of Cape Town. He is to be warmly congratulated on his achievement.

The book, dedicated to Dr. L. Bolus, lifetime honorary Curator of the Bolus Herbarium, is presented in two parts. The first part consists mainly of six chapters by collaborators on the classification, keys to genera, and historical background of the group. The second part consists mainly of the descriptions, literature citations, illustrations of the genera and a fairly comprehensive bibliography.

It is a matter of opinion whether the chapters of part one should have been arranged otherwise, beginning with the historical background and ending with the classification and keys to the genera. The latter is the more usual sequence. The inclusion of a formal description of the family would have been welcome since hitherto the group has generally been included in Aizoaceae or Ficiodaceae.

Descriptions and illustrations of 124 genera have been included in alphabetical order. It is realized by the author and the reviewer that a number of these are questionably worthy of recognition at the generic level. Fairly full literature references are included and some of the synonymy. The absence of full synonymy will be a drawback to the botanist.

The illustrations, invaluable in such a work as this, were done, mostly by Mary Page and somewhat fewer by Beatrice Carter, about 50 years ago. They were done under the critical eye of Louisa Bolus to illustrate the habit and essential details of the flowers and fruits. They were done for record purposes rather than for publication yet they are of outstanding artistic merit and are excellently reproduced. The few paintings done in recent times to complete the representation of new genera are often lifeless by comparison.

The printing, paper (gratefully not glossy) and binding leave nothing to be desired. Although the price of R21,00 may seem high the value is there.

R. A. DYER